DOCUMENT RESUME

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TITLE	Military Curriculum Materials for Vocational and Technical Education. Miniature/Microminiature Electronics Repair. CNTT W-100-0034B. Classroom Course 7-15.
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IDENTIFIERS	*Microminiature Circuits; Military Curriculum Project; *Miniature Circuits; Solderers

ABSTRACT

These instructor materials (curriculum outline, lesson plans) and student guide for a high school-postsecondary level course in miniature/microminiature electronic repair are one of a number of military-developed curriculum packages selected for adaptation to vocational instruction and curriculum development in a civilian setting. The course consists of four units containing fifteen lessons covering 118 hours of instruction: (1) Introduction to the School and Course (Introduction to the Course, Introduction to High Reliability Soldering, Preventive Maintenance of the 2M Repair Station), (2) Printed Circuit Board Repair (Conformal Coating Removal, Desoldering Printed Circuit Board Components, Printed Circuit Board Component Installation and Soldering, Repair of Damaged Printed Circuit Boards), (3) Terminal and Connector Pin Soldering (Insulation Removal, Wire Tinning and Soldering to Turret Terminals; Soldering to Hook and Pierced Tab Terminals; Soldering to Bifurcated Terminals; Soldering Connector Pins), and (4) Micro-Electronic Circuit Maintenance Techniques (Introduction to Micro-Electronic Circuit Boards, Microminiature Repair Task Identification and Procedural Analysis, Micro-Electronic Circuit Conformal Coating Removal and Desoldering Techniques, Micro-Electronic Circuit Soldering Techniques). The curriculum outline and lesson plans give the instructor this information: time allocation, training equipment, training aids, text required, references, terminal objective, enabling objectives, and outline of instruction with instructor and student activities. The student's guide contains note-taking, assignment, and job sheets. A performance test booklet is also included. (YLB)

ED193539

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

FOR FURTHER INFORMATION ABOUT
Military Curriculum Materials
WRITE OR CALL
Program Information Office
The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road, Columbus, Ohio 43210
Telephone: 614/486-3655 or Toll Free 800/848-4815 within the continental U.S. (except Ohio)

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Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

- Agriculture
- Aviation
- Building & Construction Trades
- Clerical Occupations
- Communications
- Drafting
- Electronics
- Engine Mechanics
- Food Service
- Health
- Heating & Air Conditioning
- Machine Shop
- Management & Supervision
- Meteorology & Navigation
- Photography
- Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
217/782-0759

MIDWEST
Robert Patton
Director
1515 West Sixth Ave.
Stillwater, OK 74704
405/377-2000

NORTHEAST
Joseph F. Kelly, Ph.D.
Director
225 West State Street
Trenton, NJ 08625
609/292-6562

NORTHWEST
William Daniels
Director
Building 17
Airdustrial Park
Olympia, WA 98504
206/753-0879

SOUTHEAST
James F. Shill, Ph.D.
Director
Mississippi State University
Drawer DX
Mississippi State, MS 39762
601/325-2510

WESTERN
Lawrence F. H. Zane, Ph.D.
Director
1776 University Ave.
Honolulu, HI 96822
808/948-7834

MINIATURE/MICROMINIATURE ELECTRONICS
REPAIR

Classroom Course 7-15

Developed by:

United States Navy

Development and Review Dates:

May 1979

Occupational Area:

Electronics

Target Audiences:

Grades 11 - adult

Print Pages:

938

Availability:

Vocational Curriculum
Coordination Centers

Contents:	Type of Materials:						Instructional Design:				Type of Instruction:	
	Lesson Plans:	Programmed Text:	Student Workbook:	Handouts:	Text Materials:	Audio-Visuals:	Performance Objectives:	Tests:	Review Exercises:	Additional Materials Required:	Group Instruction:	Individualized:
Unit 1 - Introduction to the School and Course	•	•			•	X	•			•	•	
Unit 2 - Printed Circuit Board Repair	•	•			•	X	•	•		X	•	
Unit 3 - Terminal and Connector Pin Soldering	•	•			•	X	•	•		•	•	
Unit 4 - Micro-Electronic Circuit Maintenance Techniques	•	•			•	X	•	•		X	•	

X Materials are recommended but not provided.

2

MINIATURE/MICROMINIATURE ELECTRONIC REPAIR (2M) PROGRAM
A-100-0034

Course Description:

This course provides maintenance personnel with the latest methods to disassemble, repair and solder miniature printed circuits, components, terminals, solderable connectors, circuit board laminates, conductors and replace electronic components on microminiature single and double sided printed circuit boards and the proper preventive maintenance procedures for the repair station and its associated components.

Unit 1 - Introduction to the School and Course contains 3 lessons covering 6 hours of instruction:

Introduction to the Course
Introduction to High Reliability Soldering
Preventive Maintenance of the 2M Repair Station

Unit 2 - Printed Circuit Board Repair - contains 4 lessons including 44 hours of instruction:

Conformal Coating Removal
Desoldering Printed Circuit Board Components
Printed Circuit Board Component Installation and Soldering
Repair of Damaged Printed Circuit Boards

Unit 3 - Terminal and Connector Pin Soldering - contains 4 lessons covering 35 hours of instruction:

Insulation Removal, Wire Tinning and Soldering to Turret Terminals
Soldering to Hook and Pierced Tab Terminals
Soldering to Bifurcated Terminals
Soldering Connector Pins

Unit 4 - Micro-Electronic Circuit Maintenance Techniques - includes 4 lessons containing 33 hours of instruction:

Introduction to Micro-Electronic Circuit Boards
Microminiature Repair Task Identification and Procedural Analysis
Micro-Electronic Circuit Conformal Coating Removal and Desoldering Techniques
Micro-Electronic Circuit Soldering Techniques

This course includes a curriculum outline and lesson plans which give the the instructor the following information: Time allocation, training equipment, training aids, text required, references, terminal objective and enabling objectives. Student materials included a student guide and a performance test booklet. The publication NHB 5300.4(3A) has been included in the course, as it is required in the curriculum outline. Please note that lesson 1 of unit 1 has been omitted because of military specific materials.

MINIATURE/MICROMINIATURE ELECTRONICS REPAIR
A-100-0034

CLASSROOM COURSE

TABLE OF CONTENTS

Volume	Page
Curriculum Outline	4
Instructor's Guide, Unit 1	40
Instructor's Guide, Unit 2	146
Instructor's Guide, Unit 3	394
Instructor's Guide, Unit 4	554
Student's Guide	720
Requirements for Soldered Electrical Connections	874
Performance Test Booklet	923

Note: Lesson 1 of Unit 1 has been omitted because of military specific materials.

CNTT W-100-0034B

CURRICULUM OUTLINE
FOR
MINIATURE/MICROMINIATURE ELECTRONIC REPAIR (2M) PROGRAM

PREPARED BY
FLEET TRAINING CENTER
NORFOLK, VIRGINIA 23511

A-100-0034

PREPARED FOR
CHIEF OF NAVAL TECHNICAL TRAINING
MAY 1979
UNCLASSIFIED

5

DEPARTMENT OF THE NAVY
CHIEF OF NAVAL TECHNICAL TRAINING
NAVAL AIR STATION MEMPHIS (75)
MILLINGTON, TENNESSEE 38054

LETTER OF PROMULGATION

1. The curriculum outline for the Miniature/Microminiature Electronic Repair (2M) Program Course A-100-0034, is a control document that sets the time allocation and sequence of instruction for the course. Contained within are the time allocations for each unit lesson topic of the course and the learning objectives to be achieved during each.

2. This curriculum outline supersedes any previously developed curriculum outline for this course and is effective upon receipt.

3. User commands are invited to submit explicit comments and/or recommendations concerning this course to the Chief of Naval Technical Training (N313), Naval Air Station Memphis (75), Millington, Tennessee 38054.

JW Sellers

J. W SELLERS
Assistant Chief of Staff
for Surface Warfare and Basic Training

COURSE DATA PAGE

1. COURSE MISSION:

To provide maintenance personnel with the latest methods to disassemble, repair and solder miniature printed circuits, components, terminals, solderable connectors, circuit board laminates, conductors and replace electronic components on microminiature single and double sided printed circuit boards and the proper preventive maintenance procedures for the repair station and its associated components as required for initial certification in the NAVSEA (2M) Program.

2. COURSE LENGTH:

120 Instructional Periods
19 Days

3. LOCATIONS AT WHICH TAUGHT:

Fleet Training Center, Norfolk, VA
Service Schools Command, San Diego, CA

4. CLASS CAPACITY:

	Norfolk	San Diego
Normal Load	12	12
Maximum Capacity	12	12

5. INSTRUCTOR REQUIREMENTS:

3 Electrical/Electronic E-6 or above

6. INSTRUCTIONAL PROGRAM MANAGER:

Chief of Naval Technical Training

7. QUOTA CONTROL:

Quota Control, Fleet Training Center, Norfolk, VA
Quota Control, Service Schools Command, San Diego, CA

8. IMPLEMENTATION DATE:

May 1979

9. PRIMARY MODE OF INSTRUCTION:

Group-paced

7

10. PRECEDING CURRICULUM OUTLINE:

November 1976

11. INSTRUMENTS AND PROCEDURES FOR MEASURING STUDENT PERFORMANCE:

Performance Tests (Final Product)

12. PERSONNEL QUALIFICATIONS STANDARDS (PQS):

None developed

FOREWORD

This document was prepared for submission to higher authority for approval. The curriculum outline serves as a planning document for development of specific training materials to be used to conduct the course of instruction. It is in outline form listing course units and lesson topics in sequential order with accompanying learning objectives both terminal and enabling. The outline organizes the course of instruction for the Miniature/Micro-Miniature Electronic Repair (2M) Program and ensures that all required subject matter is adequately covered in the course. This curriculum outline consists of front matter, the outline of instruction and annex.

To eliminate repetitious verbage in the conditions and standards of the topic objectives of this course involving high reliability soldering techniques and standards/specifications, the following information outlined in MIL-STD-454E and MIL-S-45743( ), will apply at all times:

High Reliability Soldering Techniques -

a. Throughly clean area to be soldered - remove oxidation and dirt using ink type eraser and solvent.

b. Apply flux to area to be soldered - flux cored solder or external flux.

c. Proper heat application - correctly prepared soldering iron to the mass to be soldered.

d. Proper application of solder - use heat shunt if needed, form solder bridge and apply solder to form solder bond.

e. Clean after soldering - remove all flux residues using an approved solvent.

High Reliability Soldering Standards/Specifications -

a. Solder joint possess proper quantity of solder

(1) Concave fillets on all connections

(2) Lead or wire strand contour visible

9

(3) No bare metal or copper visible

(4) No wicking of solder under wire insulation

b. Solder finish show no defects

(1) Bright, gleaming and mirror-like finish

(2) No pits, holes, peaks or fractures

(3) No chalky, sandy or irregular surfaces

c. Proper wetting action

(1) Smooth feathering of all solder edges

(2) No bays or crevices in the edge of the solder flow

(3) No spillage of solder over sides of joints or terminals

(4) Complete solder flow to the edge of the pad or terminal

d. Proper lead termination

(1) Excess lead cut off with a flush cutting tool

(2) Clinched termination lead length shall be not less than the radius of the pad and not greater than the diameter of the pad

(3) All clinched terminations must be bent in the direction of the run; semi-clinch to 45 degrees; full clinch 90 degrees and flush with the run

(4) Straight through termination lead length shall be not less than one lead diameter and not more than two lead diameters above the board surface.

(5) Lead will not overhang run or pad area.

e. No board, conductor or component damage

(1) No indication of an overheated board

(2) No conductor delamination

(3) No conductor nicks and scratches

(4) No component degradation

TABLE OF CONTENTS

FRONT MATTER PAGE

Letter of Promulgation -- i

Student Data Sheet-- iv

Foreword-- v

Table of Contents--- ix

OUTLINE OF INSTRUCTION

Unit 1.0 - Introduction to the School and Course---------------- 1

- Lesson Topic 1.2 - Introduction to the Course--------------- 3
- Lesson Topic 1.3 - Introduction to High Reliability Soldering--------------------------------- 4
- Lesson Topic 1.4 - Preventive Maintenance of the 2M Repair Station--------------------------------- 5

Unit 2.0 - Printed Circuit Board Repair------------------------- 6

- Lesson Topic 2.1 - Conformal Coating Removal---------------- 7
- Lesson Topic 2.2 - Desoldering Printed Circuit Board Components--------------------------------- 8
- Lesson Topic 2.3 - Printed Circuit Board Component Installation and Soldering-----------------10
- Lesson Topic 2.4 - Repair of Damaged Printed Circuit Boards- 12

Unit 3.0 - Terminal and Connector Pin Soldering----------------- 14

- Lesson Topic 3.1 - Soldering to Turret Terminals------------ 15
- Lesson Topic 3.2 - Soldering to Hook and Pierced Tab Terminals--------------------------------- 17

Note: Lesson Topic 1.1 and sections of the Front Matter have been omitted because of military specific materials.

II

PAGE

Lesson Topic 3.3 - Soldering to Bifurcated Terminals-------- 19

Lesson Topic 3.4 - Soldering Connector Pins----------------- 21

Unit 4.0 - Micro-Electronic Circuit Maintenance Techniques------- 22

Lesson Topic 4.1 - Introduction to Micro-Electronic Circuit Boards---------------------------------- 23

Lesson Topic 4.2 - Microminiature Repair Task Identification and Procedural Analysis--- 24

Lesson Topic 4.3 - Micro-Electronic Circuit Conformal Coating Removal and Desoldering Techniques------------------------------ 25

Lesson Topic 4.4 - Micro-Electronic Circuit Soldering Techniques------------------------------ 26

Class Schedules--- 27

ANNEX

Training Equipment List---------------------------------- 30

Training Aids-- 31

Training Aids Equipment----------------------------------- 32

Training Materials List----------------------------------- 33

References-- 34

LESSON TOPIC 1.2 INTRODUCTION TO THE COURSE

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	0.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic: NONE

ENABLING OBJECTIVES

Supported Entirely by this Lesson Topic:

1.2.1 COMPLY with classroom procedures, regulations, schedules, scholastic requirements and special instructional activities in accordance with information outlined in the Student's Guide. Compliance to the regulations, schedules and scholastic requirements as outlined is required to obtain a satisfactory completion of the course. (INFO)

Supported Partially by this Lesson Topic: NONE

LESSON TOPIC 1.3 INTRODUCTION TO HIGH RELIABILITY SOLDERING

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	0.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

1.0 INSTALL electronic components on single-sided and double-sided printed circuit boards using approved mounting styles, proper terminations and high reliability soldering techniques. Complete installation must meet acceptable reliability and quality specifications, while observing all personnel and equipment safety precautions.

ENABLING OBJECTIVE

Supported Entirely by this Lesson Topic:

1.3.1 PERFORM visual inspections of printed circuit board solder connections and DETERMINE if the physical appearance, the quantity of solder and the internal structure of the connections meet the acceptable level of standards for high reliability soldering requirements. Each student will be required to inspect their completed work throughout the course and determine that it is reliable and does not require rework, prior to submission for evaluation.

Supported Partially by this Lesson Topic: NONE

LESSON TOPIC 1.4 PREVENTIVE MAINTENANCE OF THE 2M REPAIR STATION

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
1.0 Period	1.0 Period

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

1.0 INSTALL electronic components on single-sided and double-sided printed circuit boards using approved mounting styles, proper terminations and high reliability soldering techniques. Complete installation must meet acceptable reliability and quality specifications. while observing all personnel and equipment safety precautions.

ENABLING OBJECTIVE

Supported Entirely by this Lesson Topic:

1.4.1 PERFORM the daily and weekly preventive maintenance actions on the 2M Repair Station and associated equipment as outlined in the SX-300 Maintenance Instructions and associated equipment manuals, while observing all personnel and equipment safety precautions.

Supported Partially by this Lesson Topic: NONE

UNIT 2.0 PRINTED CIRCUIT BOARD REPAIR

Instructional Periods Allotted this Unit:

Classroom	Laboratory
9.0 Periods	35.0 Periods

TERMINAL OBJECTIVES

Supported Entirely by this Unit:

2.0 REMOVE various types of conformal coatings from printed circuit boards using the chemical, heat and abrasive methods of removal with no damage or degradation to components or the printed circuit boards and observing all personnel and equipment safety precautions.

3.0 REMOVE components from selected printed circuit boards using the wicking, manual and motorized solder extraction methods of desoldering with no damage or degradation to the components or printed circuit boards. All personnel and equipment safety precautions must be observed.

4.0 REPAIR damaged printed circuit board conductors, pads, eyelets and laminates using the proper tools, accepted printed circuit repair procedures and high reliability soldering techniques to meet original reliability and configuration specifications, with no visible reliability defects that would require rework. All personnel and equipment safety precautions must be observed.

Supported Partially by this Unit and Unit 1.0

1.0 INSTALL electronic components on single-sided and double-sided printed circuit boards using approved mounting styles, proper terminations and high reliability soldering techniques. Complete installation must meet acceptable reliability and quality specifications, while observing all personnel and equipment safety precautions.

LESSON TOPIC 2.1 CONFORMAL COATING REMOVAL

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	6.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic:

2.0 REMOVE various types of conformal coatings from printed circuit boards using the chemical, heat and abrasive methods of removal with no damage or degradation to components or the printed circuit boards and observing all personnel and equipment safety precautions.

Supported Partially by this Lesson Topic: NONE

ENABLING OBJECTIVES

Supported Entirely by this Lesson Topic:

2.1.1 IDENTIFY the conformal coatings on three out of four instructor provided printed circuit boards and DETERMINE the best method of removal of each coating, utilizing the information on Chart 1 - Conformal Coating Characteristics and Chart 2 - Conformal Coating Removal Techniques, in the Student's Guide.

2.1.2 REMOVE the conformal coatings from two out of three designated components on three instructor provided printed circuit boards using the chemical, heat and/or abrasive methods of removal prior to the eighth day of the course. Coating must be removed from all lead/pad areas and along all sides of the components to a point on or slightly below the widest profile of the body with no damage or degradation to components or the printed circuit boards. All personnel and equipment safety precautions must be observed.

Supported Partially by this Lesson Topic: NONE

LESSON TOPIC 2.2 DESOLDERING PRINTED CIRCUIT BOARD COMPONENTS

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	6.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic:

3.0 REMOVE components from selected printed circuit boards using the wicking, manual and motorized solder extraction methods of desoldering with no damage or degradation to the components or printed circuit boards, observing all personnel and equipment safety precautions.

Supported Partially by this Lesson Topic: NONE

ENABLING OBJECTIVES

Supported Entirely by this Lesson Topic:

2.2.1 REMOVE a minimum of two out of three selected components from an instructor provided single-sided printed circuit board using the wicking method of desoldering, as demonstrated, prior to the eighth day of the course. Removal must be completed without causing degradation or damage to components or printed circuit board. All personnel and equipment safety precautions must be observed.

2.2.2 REMOVE a minimum of two out of three selected components from an instructor provided single-sided circuit board using the manual vacuum method of desoldering, as demonstrated, prior to the eighth day of the course. Removal must be completed without causing degradation or damage to components or printed circuit board. All personnel and equipment safety precautions must be observed.

2.2.3 REMOVE a minimum of two out of three selected components from an instructor provided double-sided printed circuit board using the motorized vacumm method of desoldering, as demonstrated, prior ot the eighth day of the course. Removal must be completed without causing degradation or damage to components or printed circuit board. All personnel and equipment safety precautions must be observed.

2.2.4 DESOLDER amd REMOVE a minimum of one out of two designated components from each of the three printed circuit boards used during conformal coating removal. Removal of components must be completed prior to the ninth day of the course, using an acceptable solder extraction method, without causing degradation or damage to components or circuit boards. All personnel and equipment safety precautions must be observed.

Supported Partially by this Lesson Topic: NONE

19

LESSON TOPIC 2.3 PRINTED CIRCUIT BOARD COMPONENT INSTALLATION AND SOLDERING

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	14.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

1.0 INSTALL electronic components on single-sided and double-sided printed circuit boards using approved mounting styles, proper terminations and high reliability soldering techniques. Complete installation must meet acceptable reliability and quality specifications, while observing all personnel and equipment safety precautions.

ENABLING OBJECTIVES

Supported Entirely by this Lesson Topic:

2.3.1 SHAPE the leads of designated electronic components to be installed on single and/or double-sided printed circuit boards, without damaging leads or components. Components shall be centered between the lead mounting points, mounted flush on the board with no visible stress on the leads and all identification markings readable, when possible.

2.3.2 INSTALL prepared components on a single-sided printed circuit board utilizing the required tools and high reliability soldering techniques. Each student will be required to satisfactorily install a minimum of two out of three flush mounted/semi-clinched terminated, two out of three flush mounted/ full clinched terminated, one out of two stress relief mounted/straight thru terminated and one out of two vertically mounted/straight thru terminated components prior to the tenth day of the course. All completed work must meet the acceptable standards for high reliability soldering with no degradation or damage to the components or printed circuit board. All personnel and equipment safety precautions must be observed.

2.3.3 INSTALL prepared components on a double-sided printed circuit board utilizing the proper tools and high reliability soldering techniques. Each student will be required to satisfactorily install a minimum of five out of seven components prior to the tenth day of the course. All completed work must meet the acceptable standards for high reliability soldering with no degradation or damage to the components or printed circuit board. All personnel and equipment safety precautions must be observed.

Supported Partially by this Lesson Topic: NONE

LESSON TOPIC 2.4 REPAIR OF DAMAGED PRINTED CIRCUIT BOARDS

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
3.0 Periods	9.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic:

4.0 REPAIR damaged printed circuit board conductors, pads, eyelets and laminates using the proper tools, accepted printed circuit repair procedures and high reliability soldering techniques to meet original reliability and configuration specifications, with no visible reliability defects that would require rework. All personnel and equipment safety precautions must be observed.

Supported Partially by this Lesson Topic: NONE

ENABLING OBJECTIVES

Supported Entirely by this Lesson Topic:

2.4.1 IDENTIFY the four types of damage common to printed circuit boards, when given a sample of each, DETERMINE the extent of repairs required and SELECT the proper repair technique to be utilized to restore each board to meet its originial reliability specifications.

2.4.2 PERFORM a laminate repair of a burned area on an instructor provided printed circuit board using the patching and/or rebuilding technique, required tools and equipment necessary to restore the printed circuit board to meet the original reliability and configuration specifications, prior to the eleventh day of the course. The completed repair must meet the following standards with no visible defects that would require rework while observing all personnel and equipment safety precautions:

a. Patch repair (when damage does not extend completely through the laminate) - Edges will be beveled and undercut; no voids or bubbles will exist in the repair material; surface will be smooth and level with original laminate.

b. Rebuilding repair (when damage extends completely through the laminate) - Same standards as patch repair and if replacement piece is used it will not touch original laminate at any point.

2.4.3 REPAIR designated conductor damage on an instructor provided printed circuit board using the required tools, equipment, accepted conductor repair procedures and high reliability soldering techniques. A minimum of one out of two flow repairs, one out of two lap repairs, one out of two clinch staple repairs and one out of two pad replacement repairs with an eyelet set in the pad will be required prior to the eleventh day of the course. The completed repairs must meet the accepable standards for high reliability soldering and the following specifications with no visible reliability defects while observing all personnel and equipment safety precautions:

a. Flow repair - Solder must extend a minimum of twice the run width on each side of the damaged area.

b. Lap repair - Repair material must overlap a minimum of two run widths on each side of the damaged area and lay flat without overhanging the original run.

c. Clinch staple repair - drilled hole diameter must not exceed more than one half the width of the run, be centered on the run and in undamaged run material.

d. Pad replacement with eyelet set in pad - Replacement pad and run must be the same size and shape as the original; pad must lay flat and be completely bonded to the board laminate; no splits will extend into barrel of the eyelet; eyelet heads must remain round in shape, must be secured firmly in place and must not extend over the original pad or run area.

Supported Partially by this Lesson Topic: NONE

UNIT 3.0 TERMINAL AND CONNECTOR PIN SOLDERING

Instructional Periods Allotted this Unit:

Classroom	Laboratory
8.0 Periods	27.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Unit:

5.0 CONNECT wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connector pins utilized in miniature electronic circuits, using the required tools and equipment, acceptable wire insulation clearance, wire position specifications and high reliability soldering techniques and standards with no visible reliability defects that would require rework. All personnel and equipment safety precautions must be observed.

Supported Partially by this Unit: NONE

LESSON TOPIC 3.1 INSULATION REMOVAL, WIRE TINNING AND SOLDERING TO TURRET TERMINALS

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	6.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

5.0 CONNECT wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connector pins utilized in miniature electronic circuits, using the required tools and equipment, acceptable wire insulation clearance, wire position specifications and high reliability soldering techniques and standards with no visible reliability defects that would require rework. All personnel and equipment safety precautions must be observed.

ENABLING OBJECTIVE

Supported Entirely by this Lesson Topic:

3.1.1 REMOVE the required amount of insulation from wires of various guages and composition to be used in high reliability soldering of miniature electronic circuit terminals and connectors, utilizing thermal type wire strippers, without causing any damage or degradation to the insulation or wire. All personnel and equipment safety precautions must be observed.

3.1.2 PREPARE wires to be solder connected to miniature electronic circuit terminals and connector pins by cleaning and tinning, maintaining the original lay of the wire strands and keeping the contour of the wire strands visible with no solder wicking under the insulation. All personnel and equipment safety precautions must be observed.

3.1.3 PREPARE miniature electronic circuit turret terminals for soldering by cleaning and tinning them without causing any visible damage and ensuring thorough solder wetting of the terminals. All personnel and equipment safety precautions must be observed.

3.1.4 CONNECT prepared wires to miniature electronic circuit turret terminals completing a minimum of two out of three single entry and one out of two double entry connections, using the required tools and high reliability soldering techniques, prior to the eleventh day of the course. Each wire shall set firmly against the terminal post, be flat on the pad throughout a minimum 180 degree to a maximum 270 degree wire wrap and have proper insulation clearance with no visible reliability defects that would require rework. On double wire connections the wires must be wrapped in the same direction, trimmed to the same length and positioned directly one above the other. The acceptable wire insulation clearance is to be no greater than two times the wire diameter (including the insulation) measured from the insulation to the entry fillet, to the minimum of the insulation not being imbedded in the solder joint. All personnel and equipment safety precautions must be observed.

LESSON TOPIC 3.2 SOLDERING TO HOOK AND PIERCED TAB TERMINALS

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	6.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

5.0 CONNECT wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connector pins utilized in miniature electronic circuits, using the required tools and equipment, acceptable wire insulation clearance, wire position specifications and high reliability soldering techniques and standards with no visible reliability defects that would require rework. All personnel and equipment safety precautions must be observed.

ENABLING OBJECTIVES

Supported Entirely by this Lesson Topic:

3.2.1 PREPARE miniature electronic circuit hook and pierced tab terminals for soldering by cleaning and tinning them, without causing any visible damage and ensuring thorough solder wetting of the terminals. All personnel and equipment safety precautions must be observed.

3.2.2 CONNECT prepared wires to prepared miniature electronic circuit hook terminals completing a minimum of two out of three single entry and one out of two double entry connections using the required tools and high reliability soldering techniques, prior to the twelfth day of the course. It is required that the wires be in firm contact with the terminals and the wire entry be vertical to the terminal mounting surface. Each wire shall be wrapped on the terminals throughout a minimum of a 90 degree to a maximum of 270 degree wire wrap, flush cut and have the acceptable insulation clearance with no visible reliability defects that would require rework. On double wire connections the wires must be wrapped in alternating directions. All personnel and equipment safety precautions must be observed.

27

3.2.3 CONNECT prepared wires to prepared miniature electronic circuit pierced tab terminals completing a minimum of two out of three single entry and one out of two double entry connections using the required tools and high reliability soldering techniques, prior to the twelfth day of the course. The wires must be in firm contact with the terminals throughout a minimum wire wrap of 90 degrees to a maximum of 270 degrees, flush cut and have acceptable insulation clearance with no visible reliability defects that would require rework. All personnel and equipment safety precautions must be observed.

Supported Partially by this Lesson Topic: NONE

LESSON TOPIC 3.3 SOLDERING TO BIFURCATED TERMINALS

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	6.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

5.0 CONNECT wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connector pins utilized in miniature electronic circuits, using the required tools and equipment, acceptable wire insulation clearance, wire position specifications and high reliability soldering techniques and standards with no visible reliability defects that would require rework. All personnel and equipment safety precautions must be observed.

ENABLING OBJECTIVES

Supported Entirely by this Lesson Topic:

3.3.1 PREPARE miniature electronic circuit bifurcated terminals for soldering by cleaning and tinning them without causing any damage and ensuring thorough solder wetting of the terminals.

3.3.2 CONNECT prepared wires to prepared miniature electronic circuit bifurcated terminals completing a minimum of two out of three single side entry and one out of two double side entry connections using the required tools, equipment and high reliability soldering techniques, prior to the twelfth day of the course. All completed work must meet the acceptable standards for high reliability soldering, each wire have the acceptable insulation clearance and all connections meet the following wire position specifications, with no visible damage or degradation that would require rework while observing all personnel and equipment safety precautions:

a. Single side entry - Wire wrap shall be 90 degrees, the wire must be in contact with the surface of the terminal base, wrapped around one ear of the terminal, in contact with the inside edge and one side of the ear and flush cut at the edge of the base without overhanging.

b. Double side entry - Has same specifications as single side entry with the following requirements: both wires enter from the same side, parallel to each other and the second wire must be wrapped on the opposite ear but not in contact with the terminal base.

Supported Partially by this Lesson Topic: NONE

LESSON TOPIC 3.4 SOLDERING CONNECTOR PINS

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	9.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

5.0 CONNECT wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connector pins utilized in miniature electronic circuits, using the required tools and equipment, acceptable wire insulation clearance, wire position specifications and high reliability soldering techniques and standards with no visible reliability defects that would require rework. All personnel and equipment safety precautions must be observed.

ENABLING OBJECTIVES

Supported Entirely by this Lesson Topic:

3.4.1 PREPARE miniature electronic circuit connector pins for soldering by cleaning and tinning the pins without causing any visible damage and ensuring thorough solder wetting of the connectors.

3.4.2 CONNECT prepared wires to prepared miniature electronic circuit connector pins completing a minimum of three out of four single entry connections using the required tools and high reliability soldering techniques prior to the thirteenth day of the course. The wire must be bottomed in the cup, aligned with the axis of the cup, have a circular concave fillet where the wire enters the cup, wire strands not visible, have no solder spillage on the outer walls and acceptable insulation clearance with no visible reliability or quality defects that would require rework. All personnel and equipment safety precautions must be observed.

Supported Partially by this Lesson Topic: NONE

UNIT 4.0 MICRO-ELECTRONIC CIRCUIT MAINTENANCE TECHNIQUES

Instructional Periods Allotted this Unit:

Classroom	Laboratory
10.0 Periods	23.0 Periods

TERMINAL OBJECTIVES

Supported Entirely by this Unit:

6.0 REMOVE selected components from conformal coated micro-electronic printed circuit boards using the correct conformal coating removal method and micro-electronic desoldering technique for each component. Removal of components must be performed with no visible damage or degradation to the components or printed circuitry while observing all personnel and equipment safety precautions.

7.0 INSTALL electronic components on micro-electronic printed circuit boards using the correct tools, approved mounting styles, proper terminations and high reliability soldering techniques. Installations must meet acceptable reliability and quality specifications while observing all personnel and equipment safety precautions.

Supported Partially by this Unit: NONE

LESSON TOPIC 4.1 INTRODUCTION TO MICRO-ELECTRONIC CIRCUIT BOARDS

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
1.0 Periods	0.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

6.0 REMOVE selected components from conformal coated micro-electronic printed circuit boards using the correct conformal coating removal method and micro-electronic desoldering technique for each component. Removal of components must be performed with no visible damage or degradation to the components while observing all personnel and equipment safety precautions.

ENABLING OBJECTIVE

Supported Entirely by this Lesson Topic:

4.1.1 PERFORM visual inspection of miniature/microminiature electronic circuit boards, their solder connections and conformal coatings. DETERMINE if the physical appearance, quantity of solder, internal structure of the connections and composition of the conformal coating meet the construction characteristics that would require micro-electronic high level repair skills and handling procedures.

Supported Partially by this Lesson Topic: NONE

LESSON TOPIC 4.2 MICROMINIATURE REPAIR TASK IDENTIFICATION AND PROCEDURAL ANALYSIS

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
4.0 Periods	0.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

6.0 REMOVE selected components from conformal coated micro-electronic printed circuit boards using the correct conformal coating removal method and micro-electronic desoldering technique for each component. Removal of components must be performed with no visible damage or degradation to the components or printed circuitry while observing all personnel and equipment safety precautions.

ENABLING OBJECTIVE

Supported Entirely by this Lesson Topic:

4.2.1 IDENTIFY by visual inspection and work piece analysis of an instructor selected damaged micro-electronic circuit board, the overall repair task to be performed to restore the board to meet its original configuration specifications, without causing any additional damage or degradation.

Supported Partially by this Lesson Topic: NONE

LESSON TOPIC 4.3 MICRO-ELECTRONIC CIRCUIT CONFORMAL COATING REMOVAL AND DESOLDERING TECHNIQUES

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
2.0 Periods	10.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic: NONE

Supported Partially by this Lesson Topic:

6.0 REMOVE selected components from conformal coated micro-electronic printed circuit boards using the correct conformal coating removal method and micro-electronic desoldering technique for each component. Removal of components must be performed with no visible damage or degradation to the components or printed circuitry while observing all personnel and equipment safety precautions.

ENABLING OBJECTIVE

Supported Entirely by this Lesson Topic:

4.3.1 EVALUATE the tasks to be performed and DETERMINE the proper conformal coating removal method and desoldering technique to be used on instructor selected micro-electronic printed circuit boards, to remove designated components. The evaluation and determination made for each situation and task, should ensure no additional damage or degradation to the components or boards.

4.3.2 REMOVE a minimum of two out of three dual-in-line type, two out of three flat pack type and two out of three TO-5 type IC's from instructor selected conformal coated micro-electronic printed circuit boards, using the correct conformal coating removal method and micro-electronic desoldering technique for each component. Removal of conformal coated components must be performed with no visible damage or degradation to the components or printed circuit boards which would require rework, prior to the fourteenth day of the course. All personnel and equipment safety precautions must be observed.

Supported Partially by this Lesson Topic: NONE

LESSON TOPIC 4.4 MICRO-ELECTRONIC CIRCUIT SOLDERING TECHNIQUES

Instructional Periods Allotted this Lesson Topic:

Classroom	Laboratory
3.0 Periods	13.0 Periods

TERMINAL OBJECTIVE

Supported Entirely by this Lesson Topic:

7.0 INSTALL electronic components on micro-electronic printed circuit boards using the correct tools, approved mounting styles, proper terminations and high reliability soldering techniques. Installations must meet acceptable reliability and quality specifications while observing all personnel and equipment safety precautions.

Supported Partially by this Lesson Topic: NONE

ENABLING OBJECTIVE

Supported Entirely by this Lesson Topic:

4.4.1 INSTALL a minimum of one out of two dual-in-line type, one out of two flat pack type and one out of two TO-5 type IC's on instructor designated micro-electronic printed circuit boards using the proper tools, approved mounting styles and terminations and high reliability soldering techniques, prior to the fifteenth day of the course. All completed work must meet the acceptable standards for high reliability soldering with no damage or degradation to the components or printed circuitry that would require rework, while observing all personnel and equipment safety precautions.

4.4.2 IDENTIFY the proper conformal coating that should be applied to various micro-electronic printed circuit boards. Identification must assure compatibility and the functional requirements of the original coating material specifications.

Supported Partially by this Lesson Topic: NONE

ANNEX

TRAINING EQUIPMENT LIST

TYPE DESIGNATOR	NOMENCLATURE	NATIONAL STOCK NR.	QUANTITY REQUIRED	PER ITEM COST
	MERP/2M Equipment Kit listed in AEL-2-6700-34022		12	$3000.00
	Stereo Zoom Microscope	NA	2	1200.00
	Pulp Reamers #10, 15, 30, 50, 70 and 90	NA	12	2.00
Dremel	Drill Press Stand and Variable Speed Moto	NA	1	

TRAINING AIDS EQUIPMENT

NOMENCLATURE	NATIONAL STOCK NR.	DEVICE DESIGNATOR NUMBER	QUANTITY REQUIRED
Projector, Slide 2 X 2, Carousel			1
Screen, Projection Standard			1
Display Board	Various printed circuit boards constructed by the instructors.		
Video Cassette Projector (3/4")			

TRAINING AIDS

NOMENCLATURE	NATIONAL STOCK NR.	DEVICE DESIGNATOR NUMBER	QUANTITY REQUIRED
35 MM Slides			
Miniature Component Repair Course	Code YXH	YXH L1-S1 thru YXH L11-S20	1 each
Microminiature Electronic Repair Course	Code YXP	YXP L2-S3 YXP L1-S4 YXP L5-S1 thru YXP L9-S32 YXP L12-S1 thru YXP L12-S13	1 each
Video Cassette			
ZAP-Static Awareness		65197-8T-0051	1 each
16mm Film			
Introduction to Micro-electronic		MN-10609A	1 each

TRAINING MATERIALS LIST

MILITARY PUBLICATIONS

NUMBER (MILPUBS)	COMPLETE TITLE
	Miniature/Microminiature Electronic Repair (2M) Program Course, Student's Guide - 1 per student

CIVILIAN PUBLICATIONS - NONE

REFERENCES

MILITARY PUBLICATIONS

NUMBER	COMPLETE TITLE
MIL-STD-454E	Electronic Equipment
MIL-S-45743()	Soldering Manual Type, High Reliability, Electrical, Electronic Instrument, Communication and Radar for Radar and Aerospace and Control System
NHB 5300.4(3A)	Requirement for Soldering Electrical Connections
MIL-C-47255(MI)	Coating, Protective for Printed Wiring Boards
MIL-C-47256(MI)	Coating, for Printed Wiring Boards, Application of
MIL-P-22629	Printed Wiring Boards
MIL-P-55110B	Printed Wiring Boards
MIL-F-55561A	Foil, Copper, Cladding for Printed Wiring Boards
MIL-S-46860(M1)	Soldering of Metallic Ribbor Lead Materials to Solder Coated Conductors, Process for Reflow
MIL-STD-275C	Printed Wiring for Electronic Equipment
MIL-F-20329A	Flux, Soldering Rosin Base General Purpose
QQ-S-571	Solder
NASA SP-5002	Soldering Electrical Connections 4th Edition 1967
NASA TM X-53335	The Effect of Gold Plating on Soldered Connections 1965 NASA
NAVSEA OD46363	Handling of Micro Components and Circuits, 21 March 1977
MIL-STD-429C	Printed Wiring and Printed Circuit, Terms and Definitions
MIL-F-14256D	Flux, Soldering, Liquid (Rosin Base)
MIL-P-28809	Printed Wiring Assemblies
MIL-P-46843B	Printed Wiring Assemblies

AUTHOR (COMMERCIAL OR CIVILIAN PUBS)	COMPLETE TITLE, PUBLISHING COMPANY, EDITION, DATE
Pace Inc. William J. Siegel	The Pace Rework and Repair (R&R) Technology Series Volumes 1, 2, 4, 5, 6, 7 and 8 1971
Howard H. Manko	Solders and Soldering, McGraw-Hill Book Co. New York, NY Copyright 1964
Pace Inc. William J. Siegal	Design Guideline for Producibility and Repairability of Electronic Assemblies, Pace Inc. 9337 Frazer Street, Silver Springs, MD
Clifford L. Barber	Solder - Its Fundamentals and Usage Third Edition, Kester Solder Company Copyright 1954, 61, 65
Charles A. Harper	Handbook of Materials and Processes for Electronics, McGraw-Hill, Copyright 1970
Clyde F. Coombs	Printed Circuit Handbook, McGraw-Hill Copyright 1967
Pace Inc.	Sodr-x-tractor SX300, General Operating and Maintenance Instructions, Copyright 1971
Dremel Mtg. Division	Dremel Moto-Tool, 1977

INSTRUCTOR'S GUIDE

FOR

MINIATURE/MICROMINIATURE ELECTRONIC REPAIR (2) PROGRAM

A-100-0034

PREPARED BY
FLEET TRAINING CENTER
NORFOLK, VIRGINIA 23511

PREPARED FOR

CHIEF OF NAVAL TECHNICAL TRAINING

JULY 1977

2665P8

TABLE OF CONTENTS

FRONT MATTER

PAGE

Cover Page---------- i

Distribution---------- iii

Record of Changes---------- iv

Table of Contents---------- v

How to Use This Instructor's Guide---------- viii

LESSON TOPIC GUIDES

1.2 - Introduction to the Course----------1-2-1

1.3 - Introduction to High Reliability Soldering----------1-3-1

1.4 - Preventive Maintenance of the 2M Repair Station----------1-4-1

2.1 - Printed Circuit Board Component Installation and Soldering----------2-1-1

2.2 - Conformal Coating Removal----------2-2-1

2.3 - Desoldering Printed Circuit Board Components----------2-3-1

2.4 - Repair of Damaged Printed Circuit Boards----------2-4-1

3.1 - Soldering to Turret Terminals----------3-1-1

Note: Lesson 1.1 and parts of the front matter have been omitted because of military specific materials.

18

PAGE

3.2 - Soldering to Hook and Pierced Tab Terminals--3-2-1

3.3 - Soldering to Bifurcated Terminals--3-3-1

3.4 - Soldering Connector Pins---3-4-1

4.1 - Introduction to Micro-Electronic Circuit Boards-------------------------------------4-1-1

4.2 - Microminiature Repair Task Identification and Procedural Analysis------------------4-2-1

4.3 - Micro-Electronic Circuit Conformal Coating Removal and Desoldering Techniques-----4-3-1

4.4 - Micro-Electronic Circuit Soldering Techniques---------------------------------------4-4-1

HOW TO USE THIS INSTRUCTOR'S GUIDE

This "Instructor's Guide" was developed from the approved "Curriculum Outline" for the course. It is intended for use as a basic outline in classroom instruction. (For guidance purposes, you should be familiar with the Curriculum Outline.) Ample space has been provided for you to make notes that will help you in teaching the course. Thus, you can readily convert it to a set of personal "Lesson Topic Guides" by making notes and by adding supplemental pages such as marked-up "Diagram Sheets" or filled-in "Notetaking Sheets." The learning objectives and the "Outline of Instruction" included in each Lesson Topic Guide prescribe the minimum content for that lesson, and will not be modified without proper authorization.

The Lesson Topic Guides are grouped in units and provide you with the Outline of Instruction for each Lesson Topic of this course. The numbering system is consistent with that used in the Curriculum Outline. The Outline of Instruction is sequenced in the same order in which the learning objectives are listed. The pages of the Lesson Topic Guides are printed in a horizontal format for ease of use in the classroom.

The two-column Lesson Topic Guide pages contain information that will help you prepare yourself for teaching the lesson. Found therein for each Lesson Topic is the security classification, the time allotment in contact hours, and the objectives as contained in the Curriculum Outline. Also, furnished is a list of all instructional materials, the Criterion Tests required, and the homework assignments.

The three-column "Outline of Instruction"/"Instructor Activity"/"Student Activity" pages contain the Outline of Instruction, developed in sufficient depth to be used as your primary teaching document. Related instructor and student activities that enhance the learning process are also listed.

"Outline of Instruction" Column. This column contains the major points of the subject matter to be covered during the lesson, in full textbook narrative form, descriptive phrases, or key words as appropriate. In general, it outlines concepts, theories, descriptions, processes, procedures, etc. For economy, if entries are not needed in the Instructor Activity or Student Activity columns, information normally printed in the Outline of Instruction column is printed across the entire page.

"Instructor Activity" Column. This column points out activities which the instructor must carry out during the lesson topic in addition to oral discussion or lecture. It includes such activities as projection of transparencies, films, or slides, and the use of charts, models, mockups, simulators, and other training aids or devices. These activities are keyed to the related subject matter.

"Student Activity" Column. This column points out student activities which will help each student during the acquisition and application phases of the learning process. Activities listed lead directly to his achievement of the objectives and development of his ability to do practical work. Typical entries include the following:

Hints for use of the Student's Guide; general and specific directions for classroom, laboratory or workshop time; notes emphasizing observance of personnel and equipment safety precautions; and security procedures which must be followed.

Modification or Revision. The teaching directions given in the Instructor and Student Activity columns reflect the best judgment of the writers as to the most effective teaching procedures. They should normally be followed as written. Should you prefer techniques or aids not listed in the Instructor Activity column, you are free to use them, subject to your supervisor's approval, provided that the topic objectives are achieved. Caution is advised in making changes before you have taught the lesson more than once. You are expected to add your personal teaching directions to those contained herein, particularly in the "Introduction," "Presentation," "Summary," and "Informal Test" areas.

You should submit your personal Lesson Topic Guide to your supervisor for approval prior to teaching the lessons for the first time.

If your experience in teaching the lesson later convinces you that changes or additions are desirable, consult with the education specialist or learning evaluator and submit your recommendations to the CDM via the appropriate channels.

Evaluation of Student Performance. Student progress will be evaluated by means of performance-based, criterion-referenced tests. Performance tests will range from informal application in the lab, guided by a Job Sheet, to formal Performance Tests also guided by Instruction Sheets. Appropriate tests for the objectives of each topic are specified in lesson outline.

Numerical grades will not be assigned. Each student will be given a final mark of SAT or UNSAT, depending upon whether he achieved each end-of-course and topic objective. To facilitate recording the student's progress, it is suggested that a locally prepared "Objective Achievement Summary Sheet" be maintained for each student.

CNT INSTRUCTION 1540.2 provides detailed guidance concerning criterion testing.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program
A-100-0034

HOMEWORK - NONE

Lesson Topic 1.2
Introduction to the Course

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 1.0 Hour
Laboratory - 0.0 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
   a. MERP/2M Kit
2. Text
   a. Student's Guide

TERMINAL OBJECTIVES

Supported entirely by this lesson topic: NONE

ENABLING OBJECTIVE

1.2.1 COMPLY with classroom procedures, regulations schedules, scholastic requirements and special instructional activities in accordance with information outlined in Student's Guide.

CRITERION TEST

The students will be tested by their compliance with course policies and assignments.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs.	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	
	1. Accomplishment of daily tasks aboard ship	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills. Seek to motivate. Tell a good tie-in story if possible.	
C. Effect	C. When following a subject matter lesson topic, do the following:	
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Overview	D. Overview lesson by:	
	1. Stating learning objectives as contained on cover page to this topic.	
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes	
	b. Asking questions	
	c. Use of criterion test	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	3. Invite questions concerning objectives and procedures.	3. Ask questions concerning objectives or procedures if in doubt.
II. PRESENTATION		
A. Purpose of the course	A. Give a brief overview of the course	A. Student take notes and ask questions.
1. To provide maintenance personnel with the latest methods to disassemble, repair and solder miniature printed circuits, components, terminals, solderable connectors, circuit board laminates and conductors to replace electronic components on microminiature single and double sided printed circuit boards and the proper preventive maintenance procedures for the repair station and its associated components.		
B. Course Terminal Objectives	B. Review the Terminal Objectives to be achieved	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Replace component parts on printed circuit boards using the correct tools and soldering techniques and apply the proper conformal coating in accordance with the procedures and to the standards outlined in MIL-STD-454D and MIL-C-47256 (MI).		
2. Remove conformal coatings from printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.		
3. Remove printed circuit components parts using the correct tools and desoldering techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Repair damaged printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in MIL-STD-454D.		
5. Connect wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connected pins using the proper tools and soldering techniques following the procedures and to the standard outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4 (3A).		
6. Replace component parts on micro-electronic printed circuit boards using the correct tools and soldering techniques and apply the proper conformal coating in accordance with the procedures and to the standard outlined in MIL-STD-454D.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
7. Remove conformal coating from micro-electronic printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in Volume 6 of PACE Rework and Repair Technology Series.		
8. Remove micro-electronic printed circuit board component parts using the correct tools and desoldering techniques following the procedures and to the standard outlined in Volume 6 of the PACE Rework and Repair Technology Series.		
9. PERFORM preventive maintenance on the 2M Repair Station following the procedures and to the standards outlined in the applicable technical manual.		
C. Reasons for the course	C. Pass around to class circuit boards repaired in fleet with UNSAT work and damage to boards.	C. Inspect boards and look for damage.

52

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Despite component reliability 1,000 times better than in the past, circuit density has increased 100,000 times. Consequently we have an ever increasing number of component failures to deal with.		
2. Even with the increasing failure rate, appproximately 80% of the failures occurring today happen to assemblies which have been previously repaired. This shows that during some part of the repair cycle the assembly is being damaged or degraded in some manner.		
3. A large part of the damage and degradation can be traced to a lack of correct training and equipment. Because of this lack, most technicians are causing serious degradation to the assemblies they repair, resulting in an increased failure rate and a much shorter assembly lifetime.		
4. Before today's highly sophisticated electronic systems were developed, the soldering program, at both the manufacturing end and in repair, was quite lak.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
5. Thus, to achieve a repair reliability in keeping with modern component reliability, this course was devised to teach you, the repair technician, the latest and best high-reliability repair techniques.		
E. Course Schedule		
1. First week: Printed Circuit Maintenance		
2. Second week: Terminals and Connector Pins		
3. Third week: Micro-miniature Printed Circuit Soldering		

Note: Section D and F have been omitted because of military specific materials.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
G. Safety	G. Stress safety points and ensure they comprehend	
1. Personal		
a. Handle and store heat tools properly to avoid burns		
b. Handle and store pointed and edged tools properly to avoid cuts		
c. Be extremely careful of rotary tools,particularly when using cutting bits.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. When using rotary tools always use eye protective goggles.		
e. Avoid prolonged skin or breathing contact of all chemicals used in the course.		
f. Avoid all eye, mouth, and open cut contact with chemicals used in the course.		
g. Do not breathe dust particles from cutting and grinding operations.		
h. Avoid any possibility of igniting flammable chemicals or materials.		

OUTLINE OF INSTRUCTION		INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
i.	Teflon releases toxic fumes at 400 degrees F. Be especially careful when thermally stripping wire as the element exceeds 400 degrees F and will cause fuming of Teflon insulation.		
j.	Use common electrical safety to avoid shocks.		
k.	Do not heat solvents. Some solvents release toxic fumes when heated. (For example, Chlorine and Phosgene gas)		
2.	Equipment		
a.	Never perform any action on the workpiece that will cause damage or degradation.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Handle all workpieces as though extremely fragile.		
c. Maintain cleanliness at all times.		
d. NEVER put enough strain on rotary tools to make them load down or bind.		
e. NEVER drop or bang an electrical power tool.		
f. Check all electrical cords for damage from hot tools, solvents or abrasion.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
g. Properly clean all tools and store in the proper place.		
h. Use each tool only in the manner for which it was designed to be used.		
H. Work Station Inventory	H. Instructor will point out each item in work station for inventory.	H. Student will make a note if any item not in station and have instructor replace any broken tools.
a. Instructor will point out all tools and materials in the workstation.		
III. APPLICATION	III. Point out each tool in work station.	III. Inventory tools. Ask questions if procedures are not clear.
A. Tool inventory		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary		
2. Purpose of summary		
B. Directions to students		
1. Questions		
2. Notes		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Recap of lesson	C. Emphasize safety and review policies if necessary.	C. Ask questions if material not clear. Check notes to insure accuracy and completeness
V. INFORMAL TEST - NONE		
VI. ASSIGNMENT - NONE		

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program
A-100-0034

Lesson Topic 1.3
Introduction to High Reliability Soldering

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 2.0 Hours
Laboratory - 0.0 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment - NONE
2. Training Aids
   a. Slides YXH-L2-S3A thru YXH-L2-S15A
3. Training Aids Equipment
   a. Projector, Slide
   b. Screen, Projection, Standard
4. Text
   a. Student's Guide
5. References
   a. MIL-STD-454D
   b. NHB-5300.4 (3A)
   c. NASA SP-5002

TERMINAL OBJECTIVE

Supported partially by this lesson topic:

1.0 REPLACE component parts on printed circuit boards using the correct tools and soldering techniques and APPLY the proper conformal coating in accordance with the procedures and to the standards outlined in MIL-STD-454D and MIL-C-47256 (M.I.).

ENABLING OBJECTIVES

When you complete this lesson topic, you will be able to:

1.3.1 IDENTIFY the characteristics of high reliability solder connections which include soldered area, solder quantity, solder finish, wetting and solder defects. Identification will be complete agreement with the information contained in MIL-STD-454D and NHB 5300.4 (3A).

1.3.2 OBSERVE all applicable equipment and personnel safety precautions, throughout the entire course of instruction, in accordance with the safety outlined in NASA Handbook SP-5002.

CRITERION TEST

Satisfactory completion of Enabling Objective 1.3.1 requires the student to answer the written study questions in Assignment Sheet 1-3-3A correctly.

Strict observance of all safety precautions throughout the course is required for satisfactory completion of Enabling Objective 1.3.2.

HOMEWORK

Read and study Notetaking Sheet 1-3-1N and complete Assignment Sheet 1-3-1A.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Overview	D. Overview lesson by:	
	1. Stating learning objectives as contained on cover pages to this topic.	
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes.	
	b. Asking questions.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	c. Use of criterion test.	
	3. Invite questions concerning objectives and procedures.	3. Ask questions concerning objectives or procedures if in doubt.
II. PRESENTATION		
A. Characteristics of solder and soldering bonding.	A. Explain and describe the characteristics while projecting the appropriate slides. Refer students to Notetaking Sheet 1-3-1N.	A. Follow lesson using the Notetaking Sheet 1-3-1N as directed. Ask questions when necessary.
1. Analysis of solder composition		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Solder - metal alloy consisting of two or more metals used in various percentages to form the solder alloy.		
b. Various elements make up solder.	b. Show slide YXH-L2-S3	
(1) Tin - Sn		
(2) Lead - Pb		
(3) Silver - Ag		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Antimony - Sb		
(5) Bismuth - Bi		
(6) Copper - Cu		
c. Bismuth and Antimony added in small percentages for special purpose applications.		
d. Copper added to solder to saturate the alloy with copper molecules slowing down the solder solvent action on soldering iron tips.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. Silver added to solder to slow down the solder washing on silver plated nonsolderable surfaces.		
f. Solder commonly used - alloy of tin and lead without special additives.		
(1) Most common alloys are 60/40 and 63/37.		
(2) Tin lead solder alloy - tin content percentage listed first.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Effects of heating and cooling solder		
a. Tin/lead solder alloys versus temperature.	a. Show slide YXH-L2-S4	
(1) At 361 degrees F, all solders from a range of 15/85 to 95/5 change from a solid to a plastic state except one.		
(2) Alloys with a single sharp melting point which change directly from a solid to a liquid with no plastic state is called an EUTECTIC alloy. 63/37 solder is known as EUTECTIC solder.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Different alloys reach full liquid state at different temperatures.		
b. As solder is heated, it passes from a solid state through a plastic and into a liquid state, with the exception of the eutectic point at which there is no plastic state.		
c. Most critical area-time-temperature range - solder is in a plastic state.		
(1) Plastic state - combination of liquid tin/lead alloy with solid pure metal crystals - either tin or lead.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Eutectic point will determine whether the crystals are pure lead of pure tin.		
(3) Lead-rich relation to eutectic point, crystalline structure pure lead.		
(4) Tin-rich relation to eutectic point, crystalline structure pure tin.		
(5) Any physical movement of solder, while cooling through plastic state, will permantently damage intermolecular crystalline structure solder alloy, resulting in fractured solder connection.	(5) STRESS this point...	

74

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) 60/40 solder - highly acceptable for electronic soldering - has advantage of forming slightly stronger joint than 63/37 solder. 60/40 solder disadvantage - plastic range is from 361 to 370 degrees F - change of fractured solder connections.		
3. Soldering flux -		
a. Soldering flux types		
(1) Chloride (ACID)		
(2) Organic		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Rosin/resin		
b. Purpose - remove surface oxides		
(1) All metals oxidize when exposed to air		
(2) Oxidation causes thin film of nonmetalic oxide to form on metal surface		
(3) Oxide film prevents metal-to-metal contact necessary for soldering		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Flux chemically breaks down surface oxides loosening film		
c. Flux characteristics		
(1) Chloride fluxes are inorganic salts - most active of fluxes. Effective on all common metals except aluminum and magnesium. Not suitable for reliable electronic soldering - highly corrosive - electrically conductive.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Organic fluxes - nearly as active as inorganic fluxes - less corrosive - easier to remove - must be completely removed to prevent corrosion - extremely short lifetime at high temperatures.		
(3) Rosin flux - ideally suited electronic soldering. Molecular structure inert at normal temperatures, breaks down and highly active at soldering temperatures. Totally noncorrosive except at soldering temperatures. Non-conducting, having 3.3 x 10^{15} (3,300 trillion) ohms per cubic inch resistivity.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Soldering flux aids forming intermetallic solder bond and improves wetting action.		
(1) Lowers existing surface tension	(1) Display slide YXH L2-S5	
(2) Wetting action aided by floating action of flux - lossened oxides carried away from solder path		
e. Use of flux a NECESSITY	e. STRESS this point...	
f. Flux available as external agent or intergral part of solder...		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
g. External agent flux applied by hand		
(1) Range from thin liquid to heavy paste		
(2) Paste fluxes contain Zinc Chloride as activating additive		
(3) Fluxes containing Zinc Chloride should never be used in high reliability soldering - corrosive		
h. Most electronics solder contain flux as integral part of solder		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Flux core	(1) Display Slide YXH-L2-S6	
(2) Standard flux sizes specified in Federal Spec QQ-S-571E		
(3) Flux content measured in percentage by volume, for a given core type. Remains constant percentage regardless of solder gauge.	(3) EMPHASIZE	
i. External flux use with flux-core solder highly recommended		
j. External flux recommended in MIL-S-45743C		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Kexter Solder Co. #1544 with #104 thinner		
(2) Alpha Metals #711 with #412 thinner		
k. Special forms and shapes of solder available		
(1) Solder preforms apply precise amounts on repetitive basis.	(1) Display slide YXH-L2-S7	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Used in production when not accessable by hand (sealed cans).		
(3) Special forms quite expensive - not normally needed		
(4) Preforms available in flux-core and solid solder		
1. Specifications for fluxes and flux-cored solders		
(1) Federal Spec O-F-506-B		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) MIL-S-6872A		
(3) MIL-F-14256C-1		
(4) MIL-F-20329A		
4. Intermetallic bond and wetting action	4. Display slide YXH-L2-S8	
a. Solder does not act as adhesive or glue		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Solder forms intermetallic bond with solderable metals - NOT by fusion or welding.		
c. Intermetallic bond formed is solvent or solution action.		
(1) Plastic melts at high temperatures but will disolve at room temperature when placed in solvent like acetone.		
(2) Dissolving action forms intermetallic bond with solderable metals.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Bond formed by solder is a completely new alloy (solder in solution with the metals being soldered).		
(4) Connection a single complete piece of metal consisting of at least three separate alloys. (base metal, base metal and solder and solder)		
d. Wetting Action - degree of ease and completeness solder spreads over surface of the metal being soldered.	d. EMPHASIZE	
e. Completeness of wetting action measured by tangent angle "dihedral angle of wetting"	e. Draw wetting action angle on chalkboard.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Small angle indicates through complete wetting		
(2) Large angle formed by sphere or bubble indicates poor wetting		
f. Wetting action is prime indication of quality and reliability of solder joint...		
5. Effect of metallic plating on solder joints		
a. Purpose		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Protects metal - prevents oxidation		
(a) Prevention of oxidation keeps base metal clean and highly solderable		
(b) Gold one of best platings - lowest of electromotive series of elements. Quite porous, however, thus applied in relatively thick layer.		
(2) Plating applied to component leads made of nonsolderable metal		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) Nonsolderable metals used to obtain special strength, flexibility and thermal expansion characteristics		
(b) Leads are plated with solderable metal		
(c) Do not damage or remove plating from base metal	(c) STRESS	
b. Effects of plating on intermetallic bond	b. Display slide XYH-L2-S9	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Platings form physical attachment with base metal, not a metallic alloy.		
(2) Soldering to plating metal alone is unsatisfactory - no true intermetallic bond established.		
(3) Remove plating from area to be soldered.		
(a) Use rubberized abrasive if plating is soft like gold.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) May be done by tinning heavily, then remove solder and plating. Heat is prime consideration using this method.		
(4) Another method of obtaining intermetallic bond on plated surfaces - apply sufficient heat for solvent action - penetrates through plating and forms an alloy with base metal.		
(a) Does not work well with heavy plating metals - slow solvent action		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) May cause solder bond to lose strength or become brittle		
(5) Best solution to plating problems - manufacturers starting to hot dip base metals in solder rather than electroplating them.	(5) Only necessary for technicans to be aware of its purpose and effects.	
(a) Coating forms actual intermetallic bond with base metal rather than physical coating		
(b) Coating easy to solder too		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(c) Method still only at manufacturing level		
c. Determining if plating harmful or advantageous to connections		
(1) Only two platings, other than hot-dip solder commonly used on areas to be solered		
(a) Gold or silver		
(b) Other plating used but in rare instances or in areas not to be soldered		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Silver - primarily on terminals and connector pins		
(a) Shape and accessibility make plating removal impractical - soldering done with plating intact		
(b) Silver wets and alloys well with solder - does not detract from joint strength		
(3) Gold - most common plating used in electronic circuitry		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Gold plating may be very harmful or very advantageous		
(a) Advantages when used on nonsolderable leads if component lead can not be soldered without solderable gold plating	(a) Tell students to make certain care must be kept to keep plating on component leads intact...	
(b) Normally harmful on printed circuit runs, pads and eyelets - detracts from joint reliability		
(5) Several detrimental effects caused by gold present in solder connections in quantities greater than 5% by weight		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) Reduces solder bond strength	(a) Display Slide YXH-L2-S10	
(b) Pull separation strengths measured between cooper wire soldered to gold plated copper run; copper wire soldered to unplated copper run		
(c) Bond with gold present only little over half strength of bond with no gold		
(d) Loss of strength due to gold alloyed with solder. Solder with gold dispersed through becomes weaker part of bond.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) Making and measuring pull test	(6) Display slide YXH-L2-S11. Note point solder bond separates in each case	
(a) Bond with no gold present separates at thinnest point.		
(b) Bond containing gold separates at surface of copper run where heaviest concentration of gold is present		
(7) Gold is detrimental - causes solder bond to become brittle		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) Brittle bond highly undesirable. Subject to cracking under stress due to thermal expansion and contraction		
(b) Brittleness caused by porous nature of gold		
(c) Visual indication - rough "frosty" solder connection		
(8) Gold on solder bond decreases wetting action		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) Very high dihedral angle of wetting		
(b) Reduces spread area of applied solder		
(9) Due to detrimental effects of gold on solder connections - necessary to remove gold plating from connection areas whenever possible, before soldering		
6. Characteristics and fabrication - quality solder joint		
a. Physical appearance		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Smooth shiny mirror like surface		
(2) Surface totally free of any pits, protrusions or other blemishes		
(3) No copper showing through soldered area		
(4) Smooth convaee fillets between component lead and surface to be soldered		
(5) Most critical indication of quality and reliability of connection - wetting action		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) No inlets - edge of soldered area		
(b) Solder must wet and blend smoothly into soldered surface - leaving no sharp edges or ridge at any point		
b. Allowable solder quantity	b. Display Slide YXH-L2-S12	
(1) Preferred quantity		
(a) Smooth concave fillet from point one half way up side of lead		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) Contour of wire or lead clearly visible through solder		
(2) Acceptable quantity	(2) Display Slide YXH-L2-S13	
(a) Fillet only slightly concave		
(b) Fillet starts 3/4 up side of lead		
(3) Excessive solder REJECT	(3) Display Slide YXH-L2-S14	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) Fillet convex		
(b) Not possible to tell if lead is even in solder joint		
(c) Air pockets possible to exist within joint and not show through to solder surface		
(4) Insufficient solder REJECT	(4) Display Slide YXH-L2-S15	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) Fillet, although concave, starts well below halfway point of lead		
(b) Intermetallic bond good but not enough to withstand vibration and expansion stresses.		
c. Internal structure		
(1) Internal metallic structure consists of several different alloys		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Alloys that make up solder connection between tinned copper lead and copper printed circuit pad		
(a) Solid copper foaming pad		
(b) Copper, tin and lead alloy - surface of pad		
(c) Tin/lead alloy - center of joint		
(d) Copper, tin and lead alloy - surface of component lead		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(e) Copper forming lead		
(f) Alloys must be complete - no air pockets foreign substance or solder defects in, joint to obtain reliable internal structure		
(3) Only positive text - Xraying or destructive examination, neither practical for technicians		
(4) Must judge internal quality by learning external appearance of defects and causes.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
7. Solder joint defects	7. Display Slide YXH-L2-S15A	
a. Description common defects		
(1) NASA lists 40 different joint defects		
(2) Defects fall under five major categories		
(a) Dirty solder joint		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Edge of solder shows lack of good wetting/ dewetting action.		
2. Only one portion shows dewetting		
3. Dewetted area has small inlets where solder didn't flow		
(b) Cold solder joint - good outward appearance except for wetting action		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Dewetting seen around most soldered surface		
2. Small protrusion of solder on surface where soldering iron tip was removed.		
(c) Fractured or disturbed solder joint		
1. Surface usually semi-shiny - good wetting		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Spider web cracked appearance on surface of solder		
3. Large cracks around component leads		
(d) Overheated solder joint - mistakenly called cold solder joint but appearance is quite different		
1. Surface generally quite dull		

CUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Rough, grainy or sandy appearance		
3. Appearance lumpy rather than sandy if overheat just beginning		
(e) Dead solder		
1. Crusty wrinkled appearance - film over solder surface		
2. Very dark dull color - may have faint light and dark streaks		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Causes of common defects		
(1) Dirty solder joint - oxidation or other foreign matter interfering with wetting action		
(2) Cold solder joint - insufficient head applied - poor heat transfer from iron tip		
(3) Fractured solder joint - physical movement of solder while changing from liquid to solid		
(4) Overheated solder joint - too much heat - too long		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Dead solder - very extreme overheat - solder may actually begin to separate - generally seen in solder left on tip of iron when not in use...		
8. Safety precautions	8. Safety precautions are the same as presented in Lesson 1.2. Reinforce students on the importance of observing all of them at all times...	
a. Personnel		
b. Tool safety		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Electrical		
III. APPLICATION - NONE		
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary.		
2. Purpose of summary.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Dead solder - very extreme overheat - solder may actually begin to separate - generally seen in solder left on tip of iron when not in use...		
8. Safety precautions	8. Safety precautions are the same as presented in Lesson 1.2. Reinforce students on the importance of observing all of them at all times...	
a. Personnel		
b. Tool safety		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Electrical		
III. APPLICATION - NONE		
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary.		
2. Purpose of summary.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Directions to students.		
1. Questions		
2. Notes		
C. Recap of lesson	C. Emphasize safety. Summarize main points of lesson.	C. Ask questions if material not clear, check notes to insure accuracy and completeness.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
V. **INFORMAL TEST**		
There is no informal test for this lesson topic.		
VI. **ASSIGNMENT**		
Assignment Sheet 1-3-1A	Provide students with the homework assignment.	Ask questions if the assignment is unclear. Complete assignment.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program A-100-0034

Lesson Topic 1.4:
Preventive Maintenance of the 2M Repair Station

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 1.0 Hours
Laboratory - 1.0 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
    a. MERP/2M Kit
2. Training Aids
    a. Slides
3. Training Aids Equipment
    a. Slide projector
    b. Screen, projection, standard
4. Text
    a. Student's Guide
5. Reference
    a. Technical Manuals for SX-200 and SX-300

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

9.0 PERFORM preventive maintenance on the 2M Repair Station following the procedures and to the standards outlined in the applicable technical manuals.

ENABLING OBJECTIVES

When you complete this lesson topic, you will be able to:

1.4.1 PERFORM daily preventive maintenance actions on the SX-200 Solder Extractor following the procedures outlined in the technical manual.

1.4.2 SERVICE hot cubby unit daily as outlined in the PACE Maintenance Manual for the SX-300 System.

1.4.3 INSPECT and CLEAN the Moto tool as required to remove all foreign matter.

CRITERION TEST

The student will perform the preventive maintenance actions on the SC-200 Extractor and hot cubby unit of the SX-300 System daily, as prescribed in the appropriate manual.

The student will keep the Moto tool clean of all foreign matter by inspection and cleaning as required while using it.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills.	
	4. Seek to motivate. Tell a good tie-in story if possible.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Effect	C. When following a subject matter lesson topic, do the following: 1. Explain relationship of this lesson to previous lesson(s) 2. Commend students for mastery of skills in previous lesson(s)	
D. Overview	D. Overview lesson by:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Stating learning objectives as contained on cover pages to this topic.	
	2. Stating procedures to be followed by the lesson.	
	a. Taking notes	
	b. Asking questions	
	c. Use of criterion test.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	3. Invite questions concerning objectives and and procedures.	3. Ask questions concerning objectives or procedures if in doubt.
II. PRESENTATION		
A. Routine maintenance	A. Point out system on slide and give lecture on maintenance as outlined in instruction	A. Take notes - ask questions
1. SX-300 system		
a. PPS-5 (Power Unit)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Check pump filters		
(a) Clean every 20 operating hours or if vacuum drops below 15 inches.		
(b) The pump filers must be cleaned at regular intervals varying with the extent of coating volatiles removed by extraction and usage.		
1 Unplug unit		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2 Remove the cover of the power source	2 Show slides	
3 Unscrew the filter jars and clean them.	3 Show slide	
4 Remove dirty filters by unscrewing hollow bolt with wrench and slip off felts.	4 Show slide	
5 Wash felts down with solvent or replace them with new ones.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Service pump quarterly		
(a) Place 4 ounces of solvent into vacuum intake while pump is running.		
(b) Catch solvent in a jar at pressure output.		
(c) Remove, clean and replace filters and filter jars using procedures set forth in sub-paragraph (10) above.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Pump-check pump vanes	(3) Show slides on breakdown of pump.	
(a) Replace when ¼ inch remains in rotor at full extension position of vanes or if vanes become nicked or cracked.		
NOTE: Follow instructions for General Operating and Maintenance instructions, Sodr-x-tractor SX-300, PACE No, 810-001 when holding any maintenance on the unit.		
(4) Hold daily inspections of all power cords and footswitch cords for any safety hazards yo personnel before using unit.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. SX-200 (Extractor Handpiece)		
(1) Remove tip at end of each shift (8 hours of operation)		
NOTE: Do not allow tip to remain in element when unit is not in use for extended periods.		
(2) Clean elements, baffle and chamber daily.		
(3) Replace cotton filter whenever dirty.		

127

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Check cord/hoses for cuts, burns, cracks, ect.		
(5) Lubricate chamber and baffle with mineral oil daily to aid in cleaning.		
(6) Check rubber seals for cracks and for correct position after each cleaning.		
c. Hot Cubby Unit		
(1) Clean sponge and platers brush daily.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Add water to sponge as required.		
2. Moto Tool - Routine Maintenance.		
a. Daily		
(1) Check tool body for cracks or loose screws.		
(2) Check chuck/collet for wear, stripped threads or cracks.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Check cord for burns, cracks and plug integrity.		
b. Weekly		
(1) Clean dust from inside housing. with low pressure air. (May be done more often if neccesary)		
(2) If in heavy use check brushes and armature for wear.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. All other electrical equipment used - routine maintenance.		
a. Daily checks		
(1) Damaged Power cords.		
(a) Burns, cracks, breaks		
(b) Solvent attack		

131

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Insulation damage		
(3) Evidence of wear		
(4) Dirt		
B. SX-300 System - Periodic Maintenance		
1. If equipment does not operate check for:		
a. Unit plugged in		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Power on		
c. Blown fuses		
d. Binding pump		
2. Frozen or broken extractor tips.		
a. Remove frozen/broken tip as follows:		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Turn off extractor, allow to cool.		
(2) Using #3 12-inch long drill and metal block with 3/16 inch hole, attempt to push tip remains out of element.		
(3) If unable to push out, slowly and carefully use drill to drill out tip. (Be careful not to scar inside of element with drill bit.)		
3. Plugged extractor element		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Attempt to push solder out with drill.		
b. Insert copper rod until it touches solder plug. Turn heat to full and allow rod to heat solder. Quickly remove rod and step on footswitch to apply vacuum and pull solder into chamber.		
c. A heavy solder plug may have to be drilled out with steps outlined for broken tips.		
4. Insufficient vacuum		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Check for the following:		
(1) Blockage of tip or element with solder.		
(2) Chamber sealed at both ends.		
(3) Flow control, valve settings correct.		
(4) Damaged or disconnected vacuum hose.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Cotton filter in chamber packed dirty, too large a piece of cotton.		
(6) Filters and pump dirty, clogged.		
(7) Leaks in pump due to loose screw, ect.		
(8) Check that filter bowls are firmly seated.		
(9) Check that pump vanes move freely and are undamaged.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(10) Check for proper rotor to housing adjustment.		
5. Insufficient heat.		
a. Check that extractor plug is firmly in socket.		
b. Check fuses for power controls		
c. Check power settings.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Check heater element for:		
(1) Tight connections.		
(2) Replace elements if bad - follow maintenance instructions manual to the letter.		
C. PACE HOT SHOT UNIT		
1. Handpieces		
a. Keep tips clean		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Keep tip retainer screws tight.		
2. No power to HS-20		
a. Power cord		
b. Switch on		
c. Fuse		
d. Check temperature control		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Safety Precautions		
1. Tool		
a. Clean and store all tools properly.		
b. Never use excessive force on any tools.		
c. Use each tool in the manner it was designed to be use.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Personal		
a. Beware of burns from hot tools.		
b. When using chemicals beware of skin, eye, and internal contact; avoid excessive inhalation of fumes.		
c. Use common electrical safety precautions to prevent injury.		
d. Wear eye protection when using moto-tool and also use approved safety respirator TC-21c-132 when cutting or grinding on printed circuit boards.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPLICATION - Job Sheet 1-4-1J	III. Supervise each student's performance, emphasizing safety	III. Complete 1-4-1J Ask questions if procedures are not clear.
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary.		
2. Purpose of summary.		
B. Directions to students.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Questions		
2. Notes		
C. Recap of lessons	C. Emphasize safety	C. Ask quesitons if material not clear; check notes to insure accuracy and completeness.
1. Routine Maintenance		
2. SX-300 System - Periodic		
3. Pace hot shot unit		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
V. INFORMAL TEST There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application".		
VI. ASSIGNMENT - NONE		

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program
A100-0034

Lesson Topic 2.1:
Printed Circuit Board Component Installation and Soldering

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 2.0 Hours
Laboratory - 6.0 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
    a. MERP/2M Kit
2. Training Aids
    a. Slides YXH-L3-S1 thru YXH-L3-S61
3. Training Aids Equipment
    a. Projector, Slide
    b. Screen, Projection, Standard
4. Text
    a. Student's Guide
5. References
    a. MIL-STD-454D
    b. MIL-C-47256 (M.I.)
    c. Vol. 6 of PACE Rework and Repair Technology Series

TERMINAL OBJECTIVES

Supported entirely by this lesson topic:

1.0 REPLACE component parts on printed circuit boards using the correct tools and soldering techniques and APPLY the proper conformal coating in accordance with the procedures and to the standards outlined in MIL-STD-454D and MIL-C-47256 (M.I.)

ENABLING OBJECTIVES

When you complete this lesson topic, you will be able to:

2.1.1 POSITION components on single and double sided printed circuit boards, using preferred mounting as outlined in MIL-STD-454D.

2.1.2 SHAPE component leads for mounting on printed boards without damaging leads or components and meeting all bend specifications as listed in MIL-STD-454D.

2.1.3 REPLACE electronic components on printed circuit boards utilizing the proper tools and soldering techniques for high quality printed circuit soler connections following the procedures and to the standards as outlined in MIL-STD-454D.

2.1.4 INSPECT printed circuit solder connections on selected boards and DETERMINE that quality and reliability are in accordahce with the standards outlined in MIL-STD-454D.

2.1.5 IDENTIFY the conformal coating application techniques that should be used on various repaired printed circuit boards. Identification will be in complete agreement with teh information contained in MIL-C-47256 (M.I.)

CRITERION TEST

Given selected single and double sided printed circuit boards the student will position a minimum of 10 components, shape their leads, install them using the accepted soldering techniques and inspect the completed work to ensure that the quality and reliability are in accordance with standards outlined in MIL-STD-454D.

The student will be required to identify by name the acceptable conformal coating application techniques outlined in MIL-C-47256 (M.I.).

HOMEWORK - NONE

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills.	
	4. Seek to motivate. Tell a good tie-in story if possible.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Effect	C. When following a subject matter lesson topic, do the following:	
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	
D. Overview	D. Overview lesson by:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Stating learning objectives as contained on cover pages to this topic.	
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes	
	b. Asking questions	
	c. Use of criterion test	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	3. Invite questions concerning objectives and procedures.	3. Ask questions concerning objectives or procedures if in doubt.
II. PRESENTATION		
A. Proper positioning of a component on a printed circuit board	A. Explain and describe the proper positioning of components on PCB's using the appropriate slides.	
1. Specifications and standards		
a. In repair, replacement components should always be installed in conformance with the original configuration		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Component bodies shall be centered between the component lead mounting points whenever design factors permit		
c. Correctly mounted components	c. Display slide YXH L3-S2, "Component Installed on Printed Circuit Board"	
(1) The flush mounting technique is the preferred method		
(2) The component body is centered between the lead mounting points		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Replacement components shall be mounted so as to make all possible identification markings readable without disturbing the component		
e. When a series of components are mounted in the same style and direction, they should be placed so that markings on all are readable from a single point (giving due regard to polarity requirements)		
f. Any mounting hardware removed, during disassembly shall be replaced when installing new component		
2. Considerations to be made		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. The following considerations take mandatory precedence over preferred mounting styles when mounting a component		
(1) Proper mounting of polarized components		
(2) Physical space limitations of original design		
b. When mandatory mounting considerations have been met, preferred configurations should be used whenever possible.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Methods of shaping component leads for mounting on a printed circuit board	B. Explain the proper methods of shaping component leads	
1. Specifications and standards		
a. Component leads shall always be straightened and cleaned prior to shaping	a. Display slide XYH L3-S3, "Straightening Transistor Leads"	
b. Straightening leads using a tool designed for the purpose	b. Describe use of special tool	
c. Leads may also be straightened by hand using anything that will NOT cut, or scrape the lead		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Leads can be cleaned using a special tool designed for the purpose	c. Display slide XYH L3-S4, "Using Special Lead Cleaning Tool"	
e. Rubber eraser to clean component leads	e. Display slide XYH L3-S5, "Eraser Cleaning of Leads"	
(1) Use an ink-type eraser for this purpose as other type erasers will leave an oily film on the lead		
(2) After cleaning leads with any method, the final cleaning step should be to wipe the lead thoroughly with solvent to remove particles left by the other cleaning methods		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. The minimum distance between the seal, where the lead enters the body of the component, and the start of the lead bend shall be NO LESS than a distance equal the diameter of the lead itself.	f. Display slide XYH L3-S6, "Lead Bend Placement From Component Lead"	
g. The minimum distance between any weld bead on the lead and the start of the lead bend shall be no less than a distance equal to twice the diameter of the lead itself and the bend shall NOT be between the weld bead and the component body	g. Display slide XYH L3-S7, "Lead Bend Placement From Component Lead Weld Bead"	
h. The minimum radius of the bend itself (sharpness of the bend) shall be no less than a distance equal to the diameter of the lead and the bend angle shall be 90 degrees at all times, except when forming special stress relief bends		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
i. After bending leads, and before inserting component on board, always clean leads with solvent to remove and skin oils and salts present due to finger contact	i. Display slide XYH L3-S8, "Component Lead Bend Radius and Angle"	
j. After installing the component on the board, the proper lead termination must be made prior to soldering		
(1) Prior to shaping lead termination, excess lead must be cut with a flush-cutting tool to the proper length	(1) Display slide XYH L3-S9, "Cutting Excess Lead From Termination"	
(2) On clinched terminations the lead length shall be not less than the diameter of the pad	(2) Display slide XYH L3-S10, "Proper Lead Length for Termination"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Semiclinched terminations have the same length specifications as full clinches	(3) Explain that lead is cut within specifications shown	
(4) All clinched terminations are bent in the direction of the run		
(5) Full clinch terminations must contact the run surface and not overhang any part of the run edge		
(6) The lead length of straight-through terminations shall be not less than one lead diameter and not more than two lead diameters above the board surface		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Recommended tools		
a. The following items are those recommended for use in cleaning, shaping, and cutting component leads		
(1) Round nose pliers		
(2) Cutting tweezers		
(3) Special lead forming tool		
(4) Orange wood stick		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Proper shaping techniques		
b. The first step in preparing for component installation is to thoroughly clean the circuit board	b. Display slide YXH-L3S11, "Cleaning Board for Component Installation"	
(1) A different style of pencil eraser can be used to remove light oxides and gold platings	(1) Display slide YXH L3-S12, "Pencil Eraser Cleaning"	
(2) Heavy oxides and thick platings may be removed with mechanical abrasion	(2) Display slide YXH L3-S13, "Removing Heavy Oxides"	
(3) Always clean board after abrading and DO NOT let solvent evaporate, wipe it away	(3) Display slide XYH L3-S14, "Cleaning After Abrasion"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Solvent cleaning may also be done with a brush. Always use a brush which has soft bristles to prevent scratching the conductor surfaces	(4) Display slide XYH L3-S15, "Another Solvent Cleaning Method"	
c. The next operation in component installation is cleaning and bending the component leads prior to insertion in board		
(1) A nylon rod may be used to bend component leads. Be sure to always hold the component body immobile and bend only the pigtail end of lead with a smooth wiping motion of the finger to prevent stress damage to component	(1) Display slide YXH L3-S16, "Bending Lead With Nylon Rod"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Methods of using round nose pliers to form 90-degree bends and stress relief loops. Always use EXTREME care not to mash the component lead during this process	(2) Display Slide YXH L3-S17, "Using Round Nose Pliers to Bend Leads"	
(3) Gripping lead GENTLY with pliers, make the bend in the the same manner as with the nylon rod	(3) Display slide XYH L3-S18, "Pliers in Use to Make 90-Degree Bend"	
(4) Ensure that component leads have bben properly bent. The correct bend position and radius with the component body centered between bends	(4) Display slide YXH L3-S19, "Results of Proper Bending"	
(5) Initial step in forming stress relief loops is to make a standard 90-degree bend in the lead	(5) Display slide YXH L3-S20, "Starting to Form Stress Relief Loop With Pliers"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) To finish the stress relief bend, grip lead just beyond 90-degree bend and wipe pigtail smoothly around plier jaw forming 180-degree loop	(6) Display slide XYH L3-S21, "Finishing Stress Relief Bend"	
(7) One of the many types of special lead forming tools along with some examples of its capabilities	(7) Display slide YXH L3-S22, "Special Lead Forming Tool"	
(8) The special tool may be used to measure proper component lead spacing. The sliding post must be locked into place with the setscrew after the posts are inserted into the component mounting holes	(8) Display slide XYH L3-S23, "Special Tool Used to Measure Lead Spacing"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(9) The upper forming posts of the tool reflect the measured lead spacing. The component is inserted into the forming posts and leads are wiped firmly against side of post	(9) Display slide YXH L3-S24, "Bending Leads to Measured Spacing"	
(10) Results of correct measuring and bending with the special. tool. Note that correct spacing and bending result in parallel leads and no bow to lead between component body and bend	(10) Display slide YXH L3-S25, "Example of Proper Measuring and Bending"	
(11) Use special tool to form stress relief loops after making standard 90-degree bend. Note that loop also provides a longer heat path when soldering and a handy thermal shunt attachment point	(11) Display slide YXH L3-S26, "Forming Stress Relief Loops With Special Tool"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. A component with leads properly bent and cleaned which is ready for insertion into a printed circuit board	d. Display slide XYH L3-S27, "Component Leads Cleaned After Bending"	
e. After bending and inserting component into board, the next step is to properly form the lead termination		
(1) A component with stress relief loops which is properly inserted into board and ready for lead termination forming	(1) Display slide YXH L3-S28, "Component Ready for Termination Forming"	
(2) If forming a straight-through termination, the lead is simply cut to proper length with flush-cutting pliers		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) To form a semiclinched termination, grip the lead END with pliers and bend in the direction of a run to a 45-degree angle without pulling on the lead. Then the lead is cut to the proper length	(3) Display slide XYH L3-S29, "Forming Semiclenched Termination"	
(4) The improperly mounted component the result of pulling on the lead while bending	(4) Display slide XYH L3-S30, "Results of Improper Bending"	
(5) After bending, the lead is cut with flush-cutting pliers, Note that the flush side of the cut is ALWAYS towards the board	(5) Display slide YXH L3-S31, "Clipping Component Lead"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) A lead being bent in preparation of forming a full clinch termination. The bending and cutting process for full clinch leads is the same as for semiclinch leads	(6) Display slide XYH L3-S32, "Forming Full Clinched Termination"	
(7) After cutting, the pigtail is fully clinched down to the board surface with a tool which will not cause damage to lead or cause damage to the board if the user slips	(7) Display slide YXH L3-S22, "Poor Method of Making Full Clinch"	
(8) The proper method of forming a full clinch using a nylon rod which will not cause any damage to either lead or board	(8) Display slide YXH L3-S34, "Correctly Forming Full Clinch"	
(9) A properly formed full clinch lead termination		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Characteristics of high quality printed circuit solder connections	C. Display slide YXH L3-S35, "Finished Full Clinch Termination" and explain the characteristics	
1. Soldered area		
a. The area to be soldered on straight-through and clinched terminations	a. Display slide YXH L3-S36, "Area to be Soldered"	
b. Note that soldered area extends beyond cut end of component lead sufficiently to form a fillet		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Solder must flow to the edge of the pad in all cases		
d. If run is plated and plating has been removed, solder shall be flowed over all exposed base metal		
e. The solder forms concave fillets between the lead and pad with no internal voids. Note that the solder does not flow into the hole on single-sided boards	e. Display slide YXH L3-S37, "Soldered Area on Single-Sided Board"	
f. On a double-sided board with plated-through holes or flat-set eyelets, the solder should completely fill the hole and cover pads on both sides of the board	f. Display slide XYH L3-S38, "Soldered Area on Double-Sided Board"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
g. The soldered area of funnel-set eyelets forms three separate solder joints, one on each side between the outer flanges and the pad, and one through the hole between the inside of the eyelet and the lead	g. Display slide YXH L3-S39, "Soldered Area of Funnel-Set Eyelets"	
2. Solder quantity		
a. Solder quantity falls into four categories: preferred, acceptable, excessive, and insufficient		
b. High quality solder connections will exhibit one of the two following solder quantities		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) The preferred solder quantity	(1) Display slide YXH L3-S40, "Preferred Soler Quantity"	
(2) An acceptable solder quantity	(2) Display slide YXH L3-S41, "Acceptable Solder Quantity"	
3. Solder finish and wetting		
a. The solder finish must exhibit the following characteristics		
(1) A smooth gleaming appearance		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) No pits or holes		
(3) All fillets must be concave		
b. Solder wetting characteristics must be as follows		
(1) The edges of the solder flow must blend smoothly into the soldered surface with no ridged or bubbled appearance		
(2) There must be no bays or crevices extending back into the solder flow		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Techniques for making high quality printed circuit solder connections		
1. Application of flux		
a. Only flux-cored solder should be used as it provides automatic application of flux to the connection while being soldered		
b. For large areas or rapidly oxidizing surfaces, a quantity of external flux may also be applied to the joints prior to soldering		
2. Proper heating		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Proper heating can only be accomplished with a correctly prepared soldering iron		
(1) A typical soldering iron used in high-reliability soldering. Note the different tip sizes which are used for different masses to be soldered	(1) Display slide YXH L3-S42, "Typical Soldering Iron"	
(2) The tip being inserted in the iron. The tip should be inserted to bottom of hole and setscrew tightened gently as excessive force will cause screw to heat-seize	(2) Display slide YXH L3-S43, "Inserting Tip"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) A properly dressed copper tip	(3) Display slide YXH L3-S44, "Dressed Copper Tip"	
(a) Copper tips should be dressed with a smooth file only when cold to prevent oxidation and solder repulsion		
(b) When using a plated copper tip, never dress the tip with a file. Clad tips should be cleaned only with a plater's brush		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) After cleaning or dressing the tip, it MUST be tinned by flowing a generous amount of new solder onto the SHAPED surface as soon as the iron is hot enough to melt solder. The iron is then allowed to idle for approximately 2 minutes unitl it reaches full operating temperature at which time additional solder is added	(4) Display slide YXH L3-S45, "Tinning the Tip"	
(5) The solder is left on the tip if the iron is not going to be used immediately. This protects the hot tip from the rapid oxidizing effects of heat		
(6) Before using the soldering iron to make a solder joint, all excess solder must be removed from the tip with a brush or Kimwipe	(6) Display slide YXH L3-S46, "Removing Solder From Tip"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(7) If the iron has idled for some time, fresh solder should be added to the tip prior to wiping off excess solder. This ensures that any impurities will flow to the surface of the solder and be removed during the wiping action		
(8) After the excess solder has been wiped off thermal shock on a wet sponge to provide a clean, dry tip for soldering	(8) Display slide YXH L3-S47, "Thermal Shocking the Tip"	
(9) A clean, dry, properly tinned tip ready for use. The thin plate (tinning) slows down oxidation and aids in heat transfer to the connection when soldering	(9) Display slide YXH L3-S48, "Clean Dry Tip"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. To achieve proper heating of the connection, the tip size and the wattage of the element must be capable of rapidly heating the mass of the joint being soldered to the melting temperature of solder		
c. When soldering a small mass connection, the applied heat may be controlled by either decreasing the size of the tip used by decreasing the power to the ireon with the variable AC control		
3. Application of solder		
a. Before applying heat a thermal shunt should be attached to component leads if dealing with heat sensitive components	a. Display slide YXH L3-S49, (using thermal shunts)	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) The component leads do not provide access for thermal shunt attachment due to the use of mounting hardware. EXTREME care must be used to prevent heat damage in this case. Some heat protection is provided by the mounting hardware and the additional lead length	(1) Display slide YXH L2-S51, "Inaccessible Component Leads"	
(2) A solder bridge is formed by melting a small amount of solder at the junction of the tip and the joint as shown. This forms a large-area, intermetallic bond between the tip and the joint, effectively making the tip a part of the joint and allowing maximum possible heat transfer rate from the tip to joint	(2) Display slide YXH L3-S52, "Forming the Heat Bridge"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) After the prepared tip is place in physical contact with both the lead and the pad and the heat bridge has been established the solder must be applied to form the solder bond		
(a) Use only clean solder		
(b) The iron should not be moved during the soldering operation even on double-sided boards since proper cleaning and heating of the jount area will allow the solder to flow through the hole and form the entire joint with a single application (except for holes without reinforcement)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(c) Solder is applied to the connection by painting the solder onto the area to be soldered using a circular motion. Start by forming fillets along sides fo lead and tinning cut end of lead; finish by filling in the large flat area of pad	(c) Display slide YXH L3-S53, "Applying Solder to Connection"	
4. Cleaning after soldering		
a. After the soldering operation is completed all flux residues must be removed by solvent cleaning	a. Display slide YXH L3-S54, "Cleaning After Soldering"	
b. Cleaning with solvent and bristle brush after soldering	b. Display slide YXH L3-S55, "Alternate Cleaning Method"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. The flux residue may also be removed using solvent and a Kimwipe as shown		
d. Do NOT allow solvent to air-dry on the board as it will leave a thin layer of flux residue behing		
e. Many solvents are approved for circuit board cleaning. The four most highly recommended solvents in order of their overall effectiveness are:		
(1) 99.5% pure ethyl alcohol		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) 99.5% pure isopropyl alcohol		
(3)		
(4)		
E. Tools used for component mounting and soldering on printed circuit boards		
1. Handtools		
a. Orangewood stick		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Thermal shunts		
c. Flush-cutting pliers		
d. Circuit board holder		
e. Magnifying lamp		
f. Bristle brush		
g. Typewriter eraser (white)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Power tools		
a. Soldering iron		
b. SX-300		
3. Materials		
a. 63/37 tin/lead solder		
b. Flux		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Kimwipes		
d. Solvent		
F. Inspecting completed printing circuit board solder connections for quality		
1. Standards of acceptance	1. Diplay slide YXH L3-S56, "Points to Check in Solder Joint Inspection"	
a. The solder joint must possess the proper quantity of solder		
b. The solder finish must show no evidence of defects		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Proper solder wetting action		
d. Proper lead termination styles		
e. No board, conductor, or component damage		
2. Indications to look for		
a. Solder quantity		
(1) Concave fillets		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Lead contour visible		
b. Solder finish		
(1) Bright gleaming finish		
(2) No pits or holes		
c. Wetting action		
(1) Smooth feathering of all edges		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) No bays or crevices in edge of flow		
d. Lead termination		
(1) Proper length		
(2) Proper positioning		
(3) Pigtail properly cut		
e. Results of using different types of cutting jaws to clip component lead	e. Display slide YXH L3-S57, "Types of Cutting Jaws"	

344

343

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. The only acceptable indication is that which shows that flush cutting jaws have been used		
g. Board, conductor, and component damage		
(1) Overheated board		
(2) Conductor delamination		
(3) Conductor nicks and scratches		
(4) Component installation		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Reasons for rejection		
a. The top row, from left to right shows the following characteristic	a. Display slide YXH L3-S58, "Completed Solder Connections" and point out the defects	
(1) Insufficient solder		
(2) Acceptable joint (proper quantity and good wetting)		
(3) Poor wetting to lead, and lead cut wrong		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The bottom row, from left to right, shows the following defects		
(1) Insufficient solder		
(2) Poor wetting action (copper showing on end of lead)		
(3) Sharp end on lead indicates improper cutting		
(4) Disturbed solder, poor wetting, and exposed copper		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
G. Applying conformal coating to a repaired printed circuit board		
1. Preparation		
a. All dirt, grease, and other foreign matter must be removed	a. Display slide YXH L3-S59, "Applying Conformal Coating"	
b. Board thoroughly dried and free of any dampness		
2. Application techniques		
a. Dipping		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Brushing		
c. Spraying		
3. Curing the coating		
a. Never cure any coating below normal room temperature		
b. Follow manufacturer's directions for best results		
H. Final inspection of a repaired printed circuit board		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Standards of acceptance		
a. Board restored to original configuration		
b. No visible degradation to any part of the assembly		
c. Conformal coating with no voids or imperfections		
2. Indication of reliability		
a. Repair made with same type components and materials as used by the manufacturer		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Repairs made should be nearly . indistinguishable fy visual inspection unless they distinguish themselves by being of a visibly higher quality than the original work of the manufacturer		
I. Safety precautions	I. Display slide YXH L3-S60, "Safety Precautions" and overview precautions. They are listed in the S/G.	
A. Workpiece		
B. Tool		
C. Personal		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPLICATION		
A. Performance Test 1.2.1T	A. Supervise each student's completion of performance test, emphasize safety, and critique each	A. Complet Performance Test 1.2.1T. Ask questions if procedures are not clear.
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student	
1. Nature of summary		
2. Purpose of summary		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Directions to students		
1. Questions		
2. Notes		
C. Recap of lesson	C. Emphasize safety	C. Ask questions if material is not clear; check notes to insure accuracy and completeness
V. INFORMAL TEST		
A. There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application"		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
VI. ASSIGNMENT	VI. Provide students with the homework assignment	VI. Ask questions if the assignment is unclear. Complete assignment.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program
A-100-0034

Lesson Topic 2.2:
Conformal Coating Removal

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 1.75 Hours
Laboratory - 3.75 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
   - a. MERP/2M Kit
2. Training Aids
   - a. Slides
     - (1) XYH L4-S1 through L4-S23
3. Training Aids Equipment
   - a. Projector, Slide
   - b. Screen, Projection, Standard
4. Text
   - a. Student's Guide
5. References
   - a. MIL-STD-454D
   - b. MIL-C-47256 (M.I.)
   - c. Vol 6, PACE Rework and Repair Technology Series

TERMINAL OBJECTIVE

Supported partially by this lesson topic:

2.0 REMOVE conformal coatings from printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.

ENABLING OBJECTIVES

When you complete this lesson topic, you will be able to:

2.2.1 IDENTIFY the basic types of conformal coatings listed in Volume 6 of the PACE Rework and Repair Technology Series and MIL-I-46058C, without error.

2.2.2 DETERMINE the proper conformal coating removal method to be used on selected printed circuit boards. Determination will be based on information contained in Volume 6 of the PACE Series.

2.2.3 REMOVE various conformal coatings from printed circuit boards using the chemical, heat, and abrasive methods and proper tools necessary as outlined in Volume 6 of the PACE Rework and Repair Technology Series.

CRITERION TEST

Given various circuit boards with different conformal coatings, the student will be required to identify the coating on a minimum of three circuit boards without error; determine the proper conformal coating removal method to be used and remove the coating using either the chemical, heat or abrasive methods as outlined on Performance Sheet 2-2-1P with minimum degradation to the boards.

HOMEWORK

Read and study Notetaking Sheet 2-2-1N and Information Sheet 2-2-1I.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	3. Personal applications of the knowledge and skills.	
	Seek to motivate. Tell a good tie-in story if possible.	
C. Effect	C. When following a subject matter lesson topic, do the following:	
	1. Explain relationship of this lesson to previous lesson(s).	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	2. Commend students for mastery of skills in previous lesson(s).	
D. Overview	D. Overview lesson by:	
	1. Stating learning objectives as contained on cover pages to this topic.	
	2. Stating procedures to be followed during the lesson.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	(a) Taking notes.	
	(b) Asking questions.	
	(c) Use of criterion test.	
	3. Invite questions concerning objectives and procedures.	3. Ask questions concerning objectives on procedures if in doubt.
II. PRESENTATION A. Characteristics and Recognition of Common Conformal Coatings		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. The five basic types	1. Display slide YXH L4-S2 and describe the five basic types of conformal coatings	
a. Epoxies		
b. Acrylic lacquers		
c. Polyurethanes		
d. Varnishes		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. RTV (Room Temperature Vulcanizing) materials		
f. Parylene		
2. Methods of identifying type by characteristics	2. Explain the various characteristics of conformal coatings.	
a. Each type of conformal coating has specific characteristics of hardness, heat resistance, adhesion, solvent reaction, texture, and brittleness.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) In audition, coating are classed as being either thick or thin	(1) Display slide YXH L4-S3	
(2) The difference between thick and thin coatings	(2) Point this out to students	
(3) A thin coating is considered to be 0.025 inch or less in thickness		
b. Individual characteristics may overlap or appear the same; however, overall characteristics evaluation will determine the conformal coating type		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Epoxy coatings have the following characteristics		
(1) Epoxy is normally the hardest of the five types of conformal coatings	(1) Display slide YXH L4-S4, pass sample of epoxy around class.	
(2) The application of heat at or near solder melting temperatures causes the epoxy to overcure, resulting in breakdown into a powdery substance		
(3) Epoxy forms the strongest surface adhesion bond of all of the conformal coatings. It will not chip or peel and may be considered nearly unbreakable under physical stresses		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Very few solvents will attack epoxy, and the ones that do will also attack the components and circuit boards themselves in most cases. Therefore, solvent testing and removal of epoxy coating is NOT a recommended procedure and should be avoided.		
(5) Texture of epoxy is normally hard, smooth and nonporous, much as an extremely hard plastic		
(6) Epoxy is normally very brittle, but due to its great adhesion strength, it does not chip or crack without the application of extreme stress		387

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Acrylic lacquers have the following characteristics	d. Display slide YXH L4-S5, pass sample around class	
(1) Acrylics are relatively hard and similar in appearance to epoxies, but they yield more readily to scraping and cutting		
(2) Heat readily softens most acrylics; however, it often results in a gummy residue		
(3) The adhesion of acrylics is usually a surface bond only and will often ship and flake, although it is relatively strong		

214

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Solvents, such as 1-1-1 trichloroethane and xylene readily attack and soften most acrylics		
(5) Texture of acrylics is normally smooth, nonporous, and of medium hardness with a glossy finish similiar to automotive lacquer paints		
(6) Acrylics are quite brittle and chip readily, but due to their brittleness do not exhibit a tendency to peel in large flakes		
e. Polyurethane coatings have the following characteristics	e. Display slide YXH L4-S6	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Polyurethane coatings are found with widely varying degrees of hardness which range from an extremely hard type, which is similar to epoxy, to a relatively soft consistency which is similar to an RTV compound		
(2) Upon application of heat, most polyurethanes tend to soften rapidly and become easily pliable exhibiting a putty-like consistency		
(3) Polyurethanes normally form a medium-strength surface bond which has a tendency to peel or flake in larger pieces than acrylics		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Plastic solvents are generally the only type solvents that will attack polyurethane coatings; however, these solvents also readily attack many electronic components		
(5) The texture of polyurethanes is usually smooth, glossy, and nonporous, but may be dented or scratched with light pressure such as a fingernail		
(6) Polyurethanes are not brittle and bend readily causing them to tear or stretch rather than crack or break		

395

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. Varnish coatings have the following characteristics		
(1) Hardness of varnishes will vary with age; new varnish is relatively hard and tough while old varnish tends to be brittle and flake off very easily	(1) Display slide YXH L4-S7	
(2) When heat is applied to varnish, it liquifies and gives off a very strong and distinctive odor of linseed oil		
(3) The adhesion of varnish coating tends to be a surface bond that will peel readily but cracks often		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Organic solvents such as alcohol and mineral spirits readily attack varnish coatings. However, these solvents leave a gummy residue on the varnish upon evaporation		
(5) The surface texture of varnish is often rather lumpy in appearance and has a semiglossy appearance		
(6) Varnish is relatively brittle therefore it flakes rather than peels		
g. RTV coatings have the following characteristics	g. Display Slide YXH L4-S8	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) RTVs have a rubbery, pliable consistency		
(2) Heat, except in excessive amounts or for long durations, has little effect on most RTVs		
(3) RTVs will be found to have a wide variety of adhesion strengths which range from readily peelable to extremely tightly bonded to the coated surface		
(4) Common solvents have no appreciable effect on RTV coatings although some may cause the surface to feel as if it has been greased with a slick lubricant		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) The texture of RTV is smooth, dull and rubbery		
(6) RTVs are not at all brittle and stretch rather than chip, crack or break		
h. Parylene coatings have the following characteristics	h. Show slide and pass board around class	
(1) Parylene is considered to be a hard coating, and is normally as hard as epoxy.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Heat, approximately 480-500F, applied with a hot knife will remove parylene; however the chance of damage to the board is very high at this temperature.		
(3) The adhesion of parylene provides a tough pinhole free coating of uniform thickness that is very tightly bonded to the coated surface		
(4) Parylene has no reaction to normal solvents		
(5) The texture is smooth and dull, and normally clear		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) Parylene is not brittle at all, and bends very easily		
B. Coating removal area	B. Display slide YXH L4-S9, and describe the areas.	
1. Areas from which the conformal coating MUST be removed in preparation for component removal from the circuit board		
2. These areas are as follows:		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Remove the coating from all lead/pad areas on both sides of the board. This will allow for free airflow through the mounting holes during desoldering of the leads		
b. Remove the coating along all sides of the component at a point ON OR BELOW the widest profile of the body		
C. Methods of removing conformal coatings	C. Display slide YXH L4-S10, and explain the various methods	
1. Chemical removal		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Chemical removal consists of the removal of coatings using solvents		
b. The only coating which is readily removable with solvents is acrylic lacquer applied in a relatively thin coating (less than 0.025 inch is considered a thin coating)		
c. Chemical removal procedures consist of the following		
(1) Apply the chemical solvent sparingly		411

410

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Apply the solvent only to the area from which the coating must be removed		
(3) For best results the solvent should be applied with a small brush or swab		
(4) Solvent should be blotted up continuously to prevent its spreading into undesired areas and to allow new solvent to attack newly exposed lower areas of the coating		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) DO NOT allow prolong soaking in solvent to prevent possible damage to the printed circuit or components		
2. Handtool removal		
a. Handtool removal consists of the removal of coating using controlled heat, scraping, and peeling		
b. Coating removal by controlled heat is effective on epoxies and polyurethanes		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Scraping and peeling removal is effective on some polyurethanes and some RTV compounds		
3. Power tool removal		
a. Power tool removal consists of the removal of coatings using abrasive grinding and abrasive cutting methods		
b. Coating removal by abrasive cutting methods is effective on all coating applied in a thick layer (greater than 0.025 inch)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Abrasive grinding removal techniques are effective on thinly applied coatings		
D. Tools used in removal of conformal coatings		
1. Handtools		
a. The following handtools are those normally used in the removal of conformal coatings		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Small bristle brush		
(2) Cotton swabs (Q-tips)		
(3) X-acto knife		
(4) Dental chisels		
(5) Tweezers		
(6) Variac		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(7) Soldering iron		
b. The bristle brush and cotton swabs are handtools used in conjunction with chemical coating removal methods		
2. Power tools		
a. The following power tools are those normally used in the removal of conformal coatings		
(1) Miniature rotary tool kit (electric)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Abrasive cutting bit set for rotary tool		
(3) Abrasive grinding bit set for rotary tool		
(4) Variac		
(5) Drill press		
3. Proper selection and use of tools		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. The selection of tools and techniques to be used in removing a particular coating will be determined by the coating type and its thickness		
b. IN ALL CASES, the methods and tools chosen SHALL be those which are least likely to cause damage or degradation of any nature. Consideration must be given to the following factors in avoiding degradation		
(1) The effects of removal technique on board material		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) The effects of removal technique on circuit board conductors		
(3) The effects of removal technique on adjacent components		
c. An evaluation of various conformal coating removal situations many tool/techniques combinations have applications in which they have proven to be reliable and effective. NO ONE METHOD best in all situations. The repair technician must make the determination of method to be used by keeping in mind at all times the REQUIREMENT Of causing NO damage or degradation to the assembly being repaired		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Heavily epoxied printed circuit board, which is a typical repair problem.	d. Display slide YXH L4-S11 and explain that it is also an example of selecting and using the ONE TOOL which must be used first on EVERY repair task. The tool referred to is the students brain which must be used to analyze thoroughly and completely each task before proceeding	
e. A coating which can be readily peeled may be removed using the following technique		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Use an X-Acto knife or dental chisel to CAREFULLY score and loosen the outer edges of the area to removed		
(2) Section to be removed is then carefully peeled away with tweezers		
f. An exaggerated example of coating removal by scraping. is an extreme likelihood of damage when using the scraping method	f. Display slide YXH	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
h. Coating is removed by scraping, and how easy it is to cause damage due to the extreme thinness of the printed circuit conductors and plating	h. Display slide YXH L4-S13.	
(1) Scraping method should only be used as a last resort and only on thick coatings		
(2) NEVER attempt to remove all of the coating with this method. Leave a thin layer and finish removal with a less dangerous technique		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) In scraping removal the tool used should have one flat side and one beveled or rounded side. The beveled side should be kept towards the board so it will have a tendency to cut up away from the board if you slip		
i. Controlled heat is the most effective method of removing coatings with handtools		
(1) Coating being removed with an uncontrolled soldering iron. An uncontrolled heat source should NEVER be used for coating removal	(1) Display slide YXH L4-S14 and stress this.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Damage caused as a result of using uncontrolled heat. Board laminate and coating are both being charred	(2) Display slide XYH L4-S15 and describe damage caused.	
j. To correctly remove coating with the use of heat, a controlled power source such as a Variac must be used in conjunction with a soldering iron		
(1) The optimum starting temperature may be obtained by adjusting the power source until the soldering iron will just barely melt solder		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Next, CAREFULLY test the iron tip on the Particular coating being removed, and if necessary, adjust the temperature slightly upward or downward for most effective removal with NO damage to the workpiece		
(3) The correct temperature range for removal of nearly all coatings is from 300 to 400 degrees F		
(4) The soldering iron tip should be shaped flat on one side and beveled on the other for safest and most effective removal		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) DO NOT attempt to remove all of the coating with this method. Leave a thin layer of coating, working carefully around component bodies and leads	(5) Display slide YXH L4-S16	
k. Damage caused by using uncontrolled heat to remove coating is plainly discernible, while the careful application of controlled heat has not caused any damage		
l. Thick conformal coatings may be cut away using the rotary tool kit in conjunction with the Variac and the abrasive cutting bit set		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) A medium-sized ball mill being used to reduce thickness of a heavy conformal coating	(1) Display slide YXH L-4-S17	
(2) As the coating gets thinner or for close areas, a smaller cutting bit should be used	(2) Display slide YXH L4-18	
(3) Once again, DO NOT attempt to remove all of the coating with this method		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
m. Extremely thick coatings such as a solid potted block may be removed using the drill press and the abrasive cutting bit set		
(1) No Variac is needed with this method since the drill press has a built-in speed control		
(2) EXTREME care must be taken when using this method since a very high probability of damage to the work-piece exists		
(3) This method of removal is performed in the following manner		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) Support the board on the bed of the drill press so that the board laminate is perfectly level with the bed		
(b) Using the mechanical lock, adjust the cutting bit to a fixed, immovable position equal to the desired depth of cut		
(c) Keeping the board level, remove the coating by lateral movement of the board beneath the rotating cutter bit (milling machine effect)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(d) This method, like previous methods, is not suitable for removal of all the coating		
n. Thinly applied coatings and coatings which have been reduced to a thin layer using other methods should be removed with the rotary tool kit and abrasive grinding bit set used in conjunction with the Variac		
(1) Hard coatings and large areas of coatings should be removed with a relatively hard grinding bit such as a grit-impregnated rubber bullet wheel		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Soft or extremely thin coatings should be removed with the rotary bristle brush		
(3) The rotary bristle brush also works well in removing coatings from hard-to-get-at areas such as around components bodies and leads		
(4) This method is most effective when it is necessary to remove all of the coating down to the board surface		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Removing all of the conformal coating by by the abrasive grinding method	(5) Display slide YXH L4-S19	
(6) Use extreme caution whenever removing an entire layer of conformal coating. Avoid damage by always using the workpiece indicators (WPIs) to gauge the progress of your work		
(a) WPIs are the indications which may be apparant to your five senses (sight, sound, touch, smell, and taste) of what is happening to the workpiece		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) The copper shows through on the solder joint. They are the changing appearance of the solder-plated run and the changing color of the coating as you penetrate the final layer		
E. Evaluating individual workpieces to determine proper techniques for removal of conformal coating		
1. A careful, thorough physical examination must be made to determine the type of conformal coating	1. Display slide YXH L4-S20	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. An analysis must be made to determine the most effective removal technique without damaging the workpiece		
F. Inspecting completed work for damage to circuit board or remaining components		
1. Board damage	1. Display slide YXH L4-S21	
a. Scorching or charring caused by component failure or improper repair techniques		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Measling, which is the appearance of white spots that are small areas of the fiber glass strands which have been exposed by heat, abrasive, or solvent action		
c. Possible cracks or breaks in the board material		
2. Conductor damage		
a. Any missing pads or conductors		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Any nicked or cracked conductors		
c. Lifted or delaminated pads or conductors		
3. Component damage		
a. Cracked, broken or overheated components		
b. Deformed or broken components leads		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
G. Safety precautions	G. Display slide YXH L4-S22, review of safety precautions	
1. Workpiece		
a. Same as previous lessons		
2. Tool		
a. Same as previous lessons		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Personal		
a. Same as previous lessons		
H. Demonstration		
1. Conformal coating removal	1. Instructor should demonstrate the proper techniques and use of tools while showing the students how to remove conformal coatings from circuit boards using the chemical, heat and abrasive methods, as covered during the lesson.	1. Observe and ask questions if necessary.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPLICATION		
Performance Sheet 2-2-1P	Supervise each student's completion of performance sheet, emphasizing safety.	Complete performance sheets. Ask questions if procedures are not clear.
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary		
2. Purpose of summary		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Directions to students		
1. Questions		
2. Notes		
C. Recap of lesson - completed during demonstration	C. Emphasize safety	C. Ask questions if material not clear; check notes to insure accuracy and completeness

470

471

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
V. INFORMAL TEST There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application."		
VI. ASSIGNMENT Read and study 2-2-1N and 2-2-1N.	Provide students with the homework assignment.	Ask questions if the assignment is unclear. Complete assignment.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program
A-100-0034

Lesson Topic 2.3:
Desoldering Printed Circuit Board Components

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 2.0 Hours
Laboratory - 3.25 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
    - a. MERP/2M Kit
2. Training Aids
    - a. Slides
        - (1) YXH L5-S1 through YXH L5-S52
3. Training Aids Equipment
    - a. Projector, Slide
    - b. Screen, Projection, Standard
4. Text
    - a. Student's Guide

1982-82P8

5. References
    - a. Volume 6, PACE Rework and Repair Technology Series

TERMINAL OBJECTIVES

Supported entirely by this lesson topic:

3.0 REMOVE printed circuit component parts using the correct tools and desoldering techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.

ENABLING OBJECTIVES

When you complete this lesson topic, you will be able to:

2.3.1 IDENTIFY the various types of printed circuit solder connections by visual inspection of selected printed circuit boards. Identification will be in agreement with the connection listed in Volume 6 of the PACE Rework and Repair Technology Series.

2.3.2 EVALUATE the repair task to be performed and DETERMINE the proper desoldering and component removal method to be used on selected printed circuit boards utilizing information contained in Volume 6 of the PACE Series.

2.3.3 DESOLDER various types of printed circuit solder connections using the wicking, manual vacuum and motorized vacuum extraction methods and proper tools necessary as outlined in Volume 6 of the PACE Series.

CRITERION TEST

Given selected printed circuit boards the student will be required to identify various solder connections, evaluate the repair tasks to be performed and correctly desolder a minimum of four components for each of the extractions methods, with minimum degradation to the circuit boards.

HOMEWORK

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills.	
	4. Seek to motivate. Tell a good tie-in story if possible.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Effect	C. When following a subject matter lesson topic, do the following:	
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	
	D. Overview lesson by:	

262

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Stating learning objectives as contained on cover pages to this topic.	
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes	
	b. Asking questions	
	c. Use of criterion test	

484

483

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	3. Invite questions concerning objectives and procedures	3. Ask questions concerning objectives or procedures if in doubt
II. PRESENTATION		
A. Recognition and characteristics of printed circuit solder-joint types	A. Using the appropriate slides explain the characteristics of the various PC solder-joint types	
1. Common joint types		
a. To recognize the various solder-joint types you must take into consideration board circuitry style, lead termination style, and the style of hole reinforcement.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Of the three considerations, board circuitry style is the easiest to recognize.		
(1) A single-sided board which has conductors on one side only	(1) Display Slide YXH L5-S2, "Comparison of Single- and Double-Sided Circuitry"	
(2) A double-sided board which has conductors on both sides		
c. The consideration of hole support is generally the hardest to identify because it is often hidden beneath the solder.		488
487		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Various hole support methods you may encounter	(1) Display Slide YXH L5-S3, "Hole Support Methods"	
(2) The methods from left to right are		
(a) No hole reinforcement in single-sided board		
(b) Plated-through hole in single-sided board		
(c) Roll-set eyelet in single-sided board		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(d) Plated-through hole in double-sided board		
(e) Funnel-set eyelet in double-sided board		
(f) Fused flat-set eyelet in double-sided board		
(3) Single-sided board which has no hole support	(3) Display Slide YXH L5-S4, "Single-Sided Board With no Hole Support"	
(4) Single-sided board which has plated-through holes	(4) Display Slide YXH L5-S5, "Single-Sided Board With Plated-Through Holes"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Module which has roll-set eyelets in a single-sided board	(5) Display Slide YXH L5-S6, "Single-Sided Board With Roll-Set Eyelets"	
(6) Double-sided board which has plated-through holes	(6) Dispaly Slide YXH L5-S7, "Plated-Through Hole in Double-Sided Board"	
(7) Double-sided board which has funnel-set eyelets	(7) Display Slide YXH L5-S8, "Double-Sided Board With Funnel-Set Eyelets"	
(8) Double-sided board with flat-set eyelets which are fused to the circuit conductors by heat and pressure	(8) Display Slide YXH L5-S9, "Double-Sided Board With Fused Flat-Set Eyelets"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Hole supports normally form interfacial connections which are a means of electrically joining the circuitry on double-sided boards		
(1) Various hole supports used as interfacial connections	(1) Display Slide YXH L5-S10, "Interfacial Connections"	
(2) From left to right on the top row, they are a clinched busswire soldered on both sides, a funnelet and a funnel-set eyelet		
(3) From left to right on the center row, they are a roll-set eyelet, a plated-through hole filled with solder, and a flat-set eyelet		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) From left to right on the bottom row, they are a flat-set fused eyelet and a petal-set fused eyelet		
(5) Star- or petal-set eyelets in use	(5) Display Slide YXH L5-S11, "Star- or Petal-Set Eyelets"	
e. The consideration of lead termination style is the final factor in determining printed circuit solder-joint lead terminations		
(1) A fully clinched lead, a common type often used in machine soldering as well as hand soldering	(1) Display Slide YXH L5-S12, "Component Lead Terminations"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) A semiclinched lead, easier to remove than a full clinch during repair		
(3) A straight-through termination which provides the greatest degree of repairability		
(4) Offset pad termination which has hole drilled outside of pad area		
(5) A crimped lead on the component side which provides component clearance for improved solvent cleaning and air circulation. This also provides clearance to prevent components with a high operating temperature from scorching the circuit board. Note that this is NOT a lead termination but a component mounting method		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) A spaded lead termination in which the end of the lead is mashed or crimped after being passed through the printed circuit board. NOTE THAT THIS STYLE OF TERMINATION IS EASILY HIDDEN BY THE SOLDER AND THAT THE LEAD MUST BE CUT BETWEEN THE COMPONENT AND THE SPADED PORTION BEFORE ATTEMPTING TO REMOVE THE LEAD FROM THE HOLE		
(7) Offset pad mounting	(7) Display Slide YXH L5-S13, "Module Using Offset Pads". NOTE that component removal is relatively easy	
(8) Improved designs of offset pads which provides greater lead length to protect the component from the heat of the soldering operation.	(8) Display Slide YXH L5-S14, "Improved Version of Offset Pads" NOTE that this type of termination MUST be hand soldered	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(9) Lap solder-joing lead termination in which the component lead does NOT pass through the circuit board.	(9) Display Slide YXH L5-S15, "Lap Joint Terminations" NOTE that a lap joint may be used with both round and flat leads	
2. Identification methods		
a. WARNING: When identifying solder-joint types, apt to find several different styles of solder-joint construction on a single printed circuit board	a. Stress this fact.	
b. Apt to encounter component leads WELDED to the printed circuit conductors		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Welded leads MUST NOT be mistaken for solder joints since they CANNOT be removed with a soldering iron.	c. Display Slide YXH L5-S16, "Example of Welded and Soldered Leads on a Single Module". NOTE that there is a combination of welded and soldered leads in the same module.	
(1) The fine black line across the component lead is the identifying characteristic of a welded joint.		
(2) Any attempt to remove the lead with a soldering iron will damage the board by overheating without disturbing the weld		
d. Means to identify board circuitry style		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Inspect visually		
(2) Use a bright light to backlight the board if needed to show relationship of interconnection paths		
e. Means to identify lead termination style		
(1) Inspect visually		
(2) Remove solder from joint to determine if there are hidden termination characteristics		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. Means to identify hole reinforcement styles		
(1) Inspect visually		
(2) Remove all solder from the connection, CAREFULLY, to dtermine hidden hole support characteristics		
B. Desoldering methods for printed circuit solder joints	B. Describe the different methods of desoldering and removing component parts from printed circuit boards	
1. Removal by wicking		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Solder removal by the wicking method consists of using finely stranded wire (either braided or twisted) in conjunction with liquid flux and heat to cause all but an extremely thin layer of solder to be removed from the joint	a. Display Slide YXH L5-S17, "The Wicking Method"	
b. Capillary action causes the solder to be drawn up into the wicking material		
c. This action is aided by the liquid flux ability to increase wetting action		
2. Manual vacuum extraction	2. Display Slide YXH L5-S18, "Manual Vacuum Extractor"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Solder removal using the manual vacuum method consists of a manually controlled and operated one-shot vacuum source in conjunction with heat to create a vacuum airflow which pulls molten solder from the joint		
b. Manual vacuum usually has the advantage of instant vacuum rise time (zero to maximum vacuum with no time delay)		
c. Manual vacuum disadvantages		
(1) Extremely high vacuum levels which may cause damage by lifting conductors from printed circuit boards since the conductor bonding material has greatly reduced strength at solder melting temperatures		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Inability, in some cases, to apply vacuum tip and source of heat to the solder joint at the same time		
(3) Short vacuum duration or physical movement of vacuum tip caused by manual operation of the vacuum source may cause incomplete solder removal, necessitating multiple applications of heat which can result in damage		
3. Motorized vacuum extraction		
a. Solder removal using motorized vacuum consists of a continuous vacuum source such as an airbottle and venturi combination or an electrically driven vacuum pump, which provides a continuous vacuum to a heated solder extraction tip and removes molten solder by vacuum airflow.	a. Display Slide YXH L5-S19, "Motorized Vacuum Extraction"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Motorized vacuum is normally controlled by a foot switch and differs from manual vacuum primarily in that it supplies a continuous vacuum		
c. Motorized vacuum extraction advantages		
(1) The vacuum can generally be set at the desired level		
(2) The extraction tip and the heat source are usually combined into one tool		
(3) Availability of continuous vacuum allows solder removal with a single application of heat		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Motorized vacuum sources may have a vacuum rise time which is slower than desired		
C. Tools used to desolder printed circuit solder joints		
1. Handtools		
a. Handtools normally used in desoldering printed circuit solder joints		
(1) Soldering iron		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Wicking material		
(3) Thermal shunts .		
(4) Various types of pliers and tweezers		
b. External flux should be used in conjunction with wire braid when desoldering by the wicking method		
2. Power tools - SX-300 Solder Extraction System		
3. Proper selection and use of tools and techniques		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. The selection of tools and techniques to be used in a particular desoldering operation will be determined by the type of solder-joint and lead termination		
b. The tools and techniques chosen MUST be those least likely to cause damage of any nature. To avoid damage, the following factors should be considered		
(1) The effect of chosen technique on board material	(1) Display Slide YXH L5-S20, "Selection and Use of Desoldering Tools"	
(2) The effect of chosen technique on circuit conductors		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) The effect of chosen technique on adjacent components		
c. Testing and evaluation techniques effective and reliable applications.	c. Stress that the technician must decide which technique is best for a specific task, keeping in mind at all times the REQUIREMENT of causing NO damage	
d. Methods of solder removal which should not be used or which have limited applications	d. Display Slide YXH L5-S21, "Inferior Methods of Solder Extraction"	
(1) At the top left is an example of the heat and shake method which should not be used since it does not remove all solder, and it causes solder to be splattered over other areas of the circuit		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) At the top center is an example of the heat and pull method which should not be used since hidden component lead terminations may cause damage when pulled		
(3) At the top right is an example of the heat and blow method which should not be used for the same reasons as the heat and shake method		
(4) At the bottome left is an example of using a squeeze-bulb solder extractor. This method is inferior due to the tip size, incomplete extraction and frequent solder spillage onto circuit		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) At the bottom right is an example of using a spring plunger extractor for solder removal. This methos has limited application since it does not work well in small areas and does not remove all of the solder		
e. Wikcing method is used to remove surface solder. The wicking method works well in removing surface solders when the following procedures are used:	e. Display Slide YXH L5-S22, "Example of Wicking"	
(1) Select a piece of wicking material (braid or stranded wire) which is smaller than the area being desoldered		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Dip the wicking material in flux and place on the area to be desoldered taking care to ensure that there is no overlap of wicking material onto the board material		
(3) As the slide shows, apply a clean, dry soldering iron tip to the braid using GENTLE pressure	(3) Display Slide YXH L5-S23, "Soldering Iron Applied to Wicking Material"	
(4) The wicking material may be drawn across the area to be desoldered after the solder melts and begins to soak into the wicking material		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) If solder stops flowing into the wicking material before it has all been removed, or if all of the flux is boiled away before removal is complete, the operation must be repeated, being sure to cut off the filled portion of the wicking material to provide a fresh wicking area for absorption of solder		
(6) Wicking material works progressively better as the number of strands increases and the size of the strands decrease		
(7) Damage can be caused by improperly using the wicking method	(7) Display Slide YXH L5-S24, "Results of Improper Wicking Procedures"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) Scorching caused by excessive heat and allowing flux to completely boil away		
(b) Measling caused by allowing hot wicking' material to overlap the pad area and contact board material		
f. A variety of manual vacuum extraction tools are available and perform with varying degrees of efficiency		
(1) Squeeze-bulb solder sucker in operation.	(1) Display Slide YXH L5-S25, "Squeeze-bulb Solder Sucker" NOTE the difficulty of applying soldering iron tip and squeeze-bulb tip at the same time	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Successful solder removal operation using the squeeze-bulb.	(2) Display Slide YXH L5-S26, "Successful Squeeze-Bulb Solder Removal" NOTE that it was performed on a large surface solder joint with an unclinched lead termination	
(3) Squeeze-bulb and soldering iron combined into one unit to overcome tip space disadvantages.	(3) Display Slide YXH L5-S27, "Squeeze-Bulb and Soldering Iron in one Unit" NOTE the difficulty of handling and the ceramic tip (which must be extremely hot because ceramic has very poor heat transfer characteristics)	
(4) Solder spillage can occur with any of the squeeze-bulb type solder extractors	(4) Display Slide YXH L5-S28, "A Disadvantage of Squeeze-Bulb Solder Extractors"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Solder extractor with a bladder (squeeze-bulb) installed inside the handle	(5) Display Slide YXH L5-S29, "Internal Bladder Solder Extractor" NOTE the distance removed solder must travel	
(6) Solder spillage caused by insufficient vacuum to draw the solder completely into the chamber	(6) Display Slide YXH L5-S30, "A Disadvantage of Internal Bladder Solder Extractors"	
g. The most efficient manual vacuum solder extractor is one which uses a spring-loaded piston to create a vacuum. The following are the proper techniques for its use.		
(1) Apply the soldering iron tip and the extractor tip to the area to be desoldered at the same time.	(1) Display Slide YXH L5-S31, "Spring Plunger Solder Extractor" NOTE that space is a very limiting factor	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Upon observing a complete solder melt, press the release trigger which will create a vacuum and cause the solder to be extracted		
(3) The extractor must be firmly held to minimize recoil which may cause the extractor tip to jump away from the joint and result in incomplete extraction and the necessity of repeating the operation several times, with resulting board damage		
(4) This method will NOT remove 100% of the solder and may cause circuit pad lifting on single-sided boards due to the extremely high vacuum which is generated		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Proper care of this tool to maintain efficient operation requires that it be disassembled and cleaned thoroughly on a regular basis		
h. The most efficient and versatile of all solder extraction methods is the motorized vacuum method		
i. Old style of motorized vacuum extractor (the vacuum source/motor unit is not shown) with a piggy-back solder trap chamber.	i. Display Slide YXH L5-S32, "Obsolescent Motorized Vacuum Extractor" NOTE the large heated mass in close proximity to components which is one of its several disadvantages	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
k. No solder baffle in the old-style solder trap tube to prevent solder buildup in the airflow exit and the chamber, which becomes very hot during use, is exposed to operator contact. This unit is also unusable for special applications which required pressure rather than vacuum since there is no positive lock on the end caps	k. Display Slide YXH L5-S34 "Disadvantages of Old-Style Solder Trap Chamber"	
l. Shown (without the motorized vacuum supply unit) is the improved solder extractor used with the SX-300 system. Note the following improvements:	l. Display Slide YXH L5-S35, "SX-300 Solder Extractor"	
(1) In-line extraction path allowing solder to be pulled directly into the solder trap chamber		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Positive locking mechanism for chamber end caps allowing unit to be used for both pressure and vacuum		
(3) Long thin heating element allowing access to confined areas		
(4) The operator is protected from contact with the hot glass solder trap chamber since it is installed within the plastic handle		
m. Motorized vacuum extraction method to achieve maximum effectiveness and minimum workpiece degradation		518

517

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
n. Extractor tip must be positioned to allow maximum airflow through the soldered connection for best results. In a dead end hole situation, the majority of the solder is removed with vacuum and the remainder is blown out with pressure. To prevent sweat joints between component leads and circuit conductors, a stirring motion of the lead with the extractor tip MUST be used	n. Display Slide YXH L5-S36, "Motorized Vacuum Extraction Techniques"	
(1) A sweat joint is a paper-thin solder joint formed by the minute amount of solder remaining on conductor and lead surfaces which cannot be removed by extraction		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) To properly prevent sweat joints from forming, the lead must be moved in a stirring motion as soon as the solder has completely melted and before vacuum is applied. The stirring motion must be maintained during the vacuum application and kept up until the airflow has caused the solder to cool and solidify. NOTE: During the stirring action, the extractor tip MUST NEVER CONTACT ANYTHING EXCEPT THE SOLDER AND THE LEAD ITSELF since contact with circuit conductors will nearly always cause damage		
o. Lead and hole size have several factors affecting solder extraction	o. Display Slide YXH L5-S38, "Selecting Extractor Tip Diameters"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) The amount of space between lead and sides of hole will affect extraction efficiency by varying the airflow through the hole		
(2) The depth of the hole will determine length of time heat must be applied for complete solder melt		
p. Both inside and outside diameters of extractor tips must be considered when selecting a tip	p. Display Slide YXH L5-S37, "Effects of Lead Clearance and Hole Size"	
(1) Inside diameter is determined by the component lead diameter over which it must fit		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Outside diameter is determined by size and mass of pad		
q. Extractor tips may be modified to fit over various lead terminations as shown	q. Display Slide YXH L5-S39, "Modifying Extractor to Fit Lead Termination"	
r. Modified extractor tip to remove solder	r. Display Slide YXH L5-S40, "Using Modified Tip"	
s. Modifying extractor tips to fit small or low-mass pads	s. Display Slide YXH L5-S41, "Modifying Extractor Tip to Fit Small or Low-Mass Pads"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) A ball mill is inserted inside the tip and used with the rotary tool as a turning and holding device		
(2) A file is used to shape the tip to the desired form		
t. Comparison of modified and unmodified extractor tips. The exposed copper on the modified tip should be tinned to prevent oxidation and improve heat transfer	t. Display Slide YXH L5-S42, "Standard and Modified Extractor Tips"	
u. The quality of solder extraction attainable by using the proper techniques is plainly shown in this slide	u. Display Slide YXH L5-S43, "Results of Proper Solder Extraction Technique"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
v. SX-300 Solder Extractor	v. Display Slide YXH L5-S44, "SX-300 Solder Extractor" Instructor use SX-300 slide to point out and describe the operation and controls	
(1) Master power switch and indicator		
(2) The footswitch which is permanently attached and controls the vacuum supply motor		
(3) The twist-lock vacuum and pressure fittings		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) The vacuum and pressure control valves which the operator must adjust for the particular extraction situation		
(5) The variable AC plug-ins and their controls NOTE: The extractor handpiece (element and tip) will attain a temperature of approximately 1,000 degrees at maximum setting of the variable AC control and MUST be used with EXTREME CAUTION. The temperature MUST be properly adjusted for each particular task to avoid causing overheat damage to the workpiece		
(6) The hot cubby and its functions		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) The soldering iron and extractor holders		
(b) The molten solder trap used to clear the extractor tip of molten solder prior to using the extractor in the pressure mode		
(c) The wiping brush used to remove excess solder from the top of the soldering iron providing what is known as a "dry iron"		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(d) The wet thermal shocking sponge used to clean oxides from the "dry" iron tip resulting in a "clean" iron tip. The wet sponge is NOT to be used for removing excess solder from the iron tip as its purpose is to remove oxides by causing the tip to rapidly and violently contract, thereby loosening any oxides which will then be removed by the wiping action		
D. Component removal after solder extraction		
1. Straight-through terminations allow the component to be lifted gently from nonconformal coated boards		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. The various clinched style terminations may require the breaking of a sweat joint which may be done by gripping the lead with pliers or tweezers and rotating the clinched portion approximately 30 degrees parallel to the board surface	2. Display Slide YXH L5-S45, "Freeing Clinched Leads"	
3. After breaking the sweat joint the lead may be lifted gently to a straight position NOTE: Do NOT attempt to lift or straighten the lead until the sweat joint is broken		
4. After the component lead is completely free and straight remove the component from a conformal coated board by		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Heating the component with a soldering iron tip or by blowing hot air from the solder extractor (preferred method) NOTE: Use EXTREME CAUTION not to cause heat damage to the workpiece	a. Display Slide YXH L5-S46, "Freeing Component From Coating"	
b. After any residual coating is softened by heat, grip the component gently with a pair of tweezers of pliers and free it from the coating with a gentle side-to-side rocking motion		
c. At this point the component may be lifted carefully from the board		
E. Evaluating individual workpieces to determine proper techniques for desoldering and removing components		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. A careful, thorough physical examination must be made to determine the solder-joint characteristics, most effective desoldering technique, and the tools to be used in applying these techniques	1. Display Slide YXH L4-S47, "Component Desoldering and Removal Evaluation"	
2. A careful step-by-step analysis of the task as it is performed MUST take into consideration possible hidden characteristics		
F. Inspecting completed work for damage to circuit board or remaining components	F. Display Slide YXH L5-S48, "Desoldering and Removal Task Completion Inspection"	
1. Board damage		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Scorching or charring caused by component failure or improper repair techniques		
b. Measling which is the appearance of white spots that are small areas of the fiber glass strands which have been exposed by heat, abrasive, or solvent action		
c. Possible cracks or breaks in the board material		
2. Conductor damage		
a. Any missing pads or conductors		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Any nicked or cracked conductors		
c. Lifted or delaminated pads or conductors		
3. Component damage		
a. Cracked, broken, or overheated components		
b. Deformed or broken component leads		
c. Poor solder joints and loose or splashed solder which may cause shorts		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
G. Safety precautions		
1. Workpiece		
a. Never perform any action on the workpieces which will cause damage or degradation		
b. Handle all workpieces as extremely fragile		
c. Maintain scrupulous cleanliness at all times		
2. Tool		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Properly clean all tools and store in proper place		
(1) Special care is necessary in maintaining the SX-300 Solder Extraction systems	(1) Display Slide YXH L5-S49, "Removing Glass Chamber"	
(2) Proper removal of the glass chamber is shown in this slide. Use a gentle push-turn motion to release the retaining cap and carefully withdraw the glass chamber to avoid breakage		
(3) Bristle brush is used to clean the glass chamber after carefully pushing out the metal baffle and the cotton vapor trap. A light coating of mineral oil will aid in future cleaning.	(3) Display Slide YXH L5-S50, "Cleaning Glass Chamber"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) The extractor element is cleaned with the small wire brush after the tip is removed. Cleaning and tip removal must be performed AT LEAST once daily, (8 hours operation) and the extractor shall be stored with the tip removed	(4) Display Slide YXH L5-S51, "Cleaning Extractor Element"	
(5) For periodic and unscheduled maintenance of the SX-300 power and vacuum supply refer to the equipment handbook		
b. Never use excessive force on any tool		
c. Use each tool only in the manner for which it was designed to be used		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Check all electrical cords for damage from hot tools, solvents or abrasion		
3. Personal		
a. Beware of burns from hot tools (keep tools in holders provided)		
b. Avoid prolonged skin contact and excessive breathing of chemicals and fumes		
c. Beware of flammable chemicals and materials		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPLICATION		
A. Performance Test 2.3	A. Supervise each student's completion of performance test, emphasizing safety.	A. Complete performance test 2.3. Ask questions if procedures are not clear.
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student	
1. Nature of summary		
2. Purpose of summary		
B. Directions to students		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Questions		
2. Notes		
C. Recap of lesson	C. Emphasize safety	C. Ask questions if material not clear; check notes to insure accuracy and completeness
V. INFORMAL TEST		
A. There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application"		
VI. ASSIGNMENT	VI. Provide students with the homework assignment	VI. Ask questions if the assignment is unclear. Complete assignment.

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NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M)
Program A-100-0034

Lesson Topic 2.4:
Repair of Damaged Printed Circuit Boards .

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 3.0 Hours
Laboratory - 8.0 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
   a. MERP/2M Kit
2. Training Aids
   a. Slides YXH -L6-S1 Thru YXH-L6-S58
3. Training Aids Equipment
   a. Projector, Slide
   b. Screen, Projection, Standard
4. Text
   a. Student's Guide
5. References
   a. MIL-STD-454D
   b. MIL-STD-275C

TERMINAL OBJECTIVES:

Supported Partially by this lesson topic:

4.0 REPAIR damaged printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in MIL-STD-454D.

ENABLING OBJECTIVES:

When you complete this lesson topic, you will be able to:

2.4.1 IDENTIFY the four categories of damage common to printed circuit boards as identified in MIL-STD-275C and 454D.

2.4.2 DETERMINE the extent of repair required and proper repair techniques to be used on any printed circuit board in accordance with information contained in MIL-STD-275C and 454D.

2.4.3 REPAIR damaged printed circuit board laminates, conductors and eyelets using the proper tools and techniques and to the standards outlined in MIL-STD-275C and 454D.

CRITERION TEST

On Assignment Sheet 2.4.1 the student will identify the four categories of circuit board damage without error.

3/5

Given selected circuit boards the student will DETERMINE the extent of repair required and repair damaged printed circuit board laminates, conductors and eyelets following procedures outlined on Performance Sheet 2-4-1P and to the standards outlined in MIL-STD-454D & 275C.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills.	
	4. Seek to motivate. Tell a good tie-in story if possible.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Effect	C. When following a subject matter lesson topic, do the following:	
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	
D. Overview	D. Overview lesson by:	
	1. Stating learning objectives as contained on cover pages to this topic.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes	
	b. Asking questions	
	c. Use of criterion test	
	3. Invite questions concerning objectives and procedures.	3. Ask questions concerning objectives or procedures if in doubt.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
II. PRESENTATION		
A. Types of circuit board damage	A. Explain each type of damage and pass sample around class and answer questions.	A. Students take notes, ask questions and watch slides.
1. Four common categories of damage.		
a. Cracked boards		
b. Scorched, charred or deeply burned boards.		
c. Broken boards.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Delaminated circuit board layers		
2. Determining extent of damage.		
a. Cracked boards		
(1) Length and depth of crack must be determined by physical inspection.		
(2) Disruption to conductors and components caused by crack must be determined.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Care must be taken in examining cracked boards not to cause additonal damage.		
b. Scorched, charred or deeply burned boards.		
(1) Determine the area of the board affected by discoloration of the surface, molten or blacken conductors and burned, melted or blackened components.		
(2) Determine the depth of the affected area which may range from a slight surface discoloration to a gaping hole through the circuit board.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Broken boards.		
(1) Determine if all parts of the board are present.		
(2) Determine if circuit conductors or components have been affected by the break.		
(3) Determine if the broken pieces may be rejoined reliably or if new pieces must be manufactured.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Delaminated circuit board layers	d. This type of damage, unless occuring in a limited area is beyond the capabilities of field tools and techniques and requires manufacture of a new board lamiante.	
(1) Determine area of delamination.		
(2) Determine if circuit conductors or components have been affected by the delamination.		
B. Circuit board repair techniques	B. Display slide YXH-L6-S3	

325

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Patching		
a. Damage which does not extend completely through the circuit board may be repaired by the patching technique.		
b. The patching technique consists of the following steps:		
(1) If the board is scorched, charred or burned, remove all discolored board material by abrasive methods.		
(2) Repairable delaminations which do not extend to the edge of the circuit board should be but away by abrasive methods until no delaminated material remains.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Do not remove delamianted material if a repairable delamination exists which extends to the edge of the printed circuit board.		
(4) After removing all damaged board material, bevel and/or undercut the edge of the removed area to provide physical holding points for the repair material.		
(5) Clean thoroughly with solvent to remove all loose particles.		
(6) Mix a compound of epoxy and powdered fiber glass and fill the cutaway area with this compound, being EXTREMELY careful to leave no voids or air bubbles.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(7) Level the surface of the filled-in area being sure that the surface of the fill material is no lower than the original board surface.	(7) NOTE: Epoxy will not stick to plastic used.	
(8) In the case of delaminations on the edge of a board, fill the delamianted layers COMPLETELY with the repair mixture and clamp firmly together between two flat surfaces.	(8) Stress this point.	
(9) Cure the epoxy repair mixture completely as per the manufactures instructions found on the package.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(10) After cure is completed, smooth the repaired surface to the same level as the original board using abrasive methods.		
(11) If necessary, redrill any holes which existed in the damaged area and clean the repair throughly.		
2. Rebuilding		
a. Damage which extends completely through the board, such as cracks, breaks and holes, must be repaired using rebuilding techniques.		
b. Cracks are repaired using the following steps:		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Remove all chips and fractured material using abrasive methods.		
(2) Bevel and undercut the edges of the removed area to provide NEEDED physical bond strength.		
(3) Fasten a smooth surface tightly against one side of the removed area.		
(4) Using clamps fasten the board firmly and immovably, keeping any loose pieces in proper alignment and with the uncovered side of the repair area up.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Mix a compound of epoxy and powdered fiber glass, and fill the cutaway area with this compound being extremely careful to leave no voids or air bubbles.		
(6) Level the surface of the filled-in area being sure that the surface of the fill material is no lower than the original board surface.		
(7) Cure, smooth, redrill and clean as in the patching method.		
c. Breaks and holes are repaired in the same manner as cracks unless broken pieces are missing or the hole exceeds 1/2 inch in diameter, in which case the following repair steps are used:		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Using the same technique as with crack repair, prepare the damaged edges.		
(2) Using a scrap board of the same type and thickness, cut a piece that duplicates as nearly as possible the missing area. Prepare the edges of this cut piece in the same manner.		
(3) Tightly fasten a smooth surface over one side of the surface over one side of the repair area and firmly clamp the board in an immovable position with the uncovered side of the board up.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Tightly fasten a smooth surface over one side of the repair area and firmly clamp the board in an immovable position with the uncovered side of the board up.		
(4) Position the replacement piece as nearly as possible to duplicate the original board configuration.		
(5) Complete the repair using the same epoxy-fiber glass mixture and repair techniques as in the patching repair method.		
C. Tools and materials used in circuit board repair.	C. Display Slide YXH L6-S4	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Handtools		
a. The following handtools are those normally used in circuit board repair:		
(1) X-Acto knife		
(2) C clamp		
(3) Various dental files and chisels.		
(4) Mixing slab		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Spatula		
(6) Bristle brush		
(7) Vise		
2. Power tools		
a. The following power tools are those normally used in circuit board repair.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Rotary tool kit		
(2) Abrasive cutting and grinding bit set.		
(3) Drill press		
(4) Variac		
(5) Curing oven, if available.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Materials		
a. The following material are those normally used in circuit board repair.		
(1) Cleaning solvent		
(2) Kimwipes		
(3) Epoxy		
(4) Fiber glass powder		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Masking tape		
(6) Scrap circuit boards		
D. Types of printed circuit run and pad damage.	D. Display Slide YXH L6-S7	
1. Cracked conductors	1. Display Slide YXH L6-S5	
a. Cracks in conductors may be partially or completely through the conductor.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Crack damage which includes nicks and scratches in the conductor must be repaired if it exceeds one-tenth of the cross sectional area of the conductor.		
2. Missing conductors	2. Display Slide YXH L6-S6.	
a. In this type of damage, pads or conductor runs are completely missing from the board.		
b. In this category conductors are present but physically damaged to a point beyond repair.		
3. Delaminated conductors	3. Display Slide YXH L6-S6.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Delaminated conductors are those which are no longer bonded to the board surface.		
b. The delamination may occur at any portion of the conductor.		
c. Examples of conductors delaminated at the termination and in the middle.		
E. Printed circuit run and pad repair techniques		
1. Crack repair		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Cracks in printed circuit conductors are repaired using the following techniques.		
(1) One method of repair is to flow solder across the crack, forming a "solder bridge". This is not a high-reliability repair (since the solder in the break will crack easily) and should be used only when no other technique can be used.	(1) NOTE: "Flow Repair"	
(2) Another method of repair is to lap solder the crack. This method is somewhat stronger than a solder bridge, but still is not highly reliable as it is also subject to solder cracking.	(2) NOTE: "Lap Repair"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) A third repair technique is to drill a hole through the board where the crack is (always drill the hole smaller than the width of run), then install and solder an eyelet. This method is highly reliable but will only work when there is no conductor on the other side of the board opposite the break which may be shorted by the eyelet.	(3) NOTE: "Eyelet Repair" EYELET installation techniques will be covered later in this lesson.	
(4) The clinched staple method of crack repair, which this slide shows, is the most reliable and may be used in nearly all cases. Care must be taken when using this technique not to drill the holes through conductors on the opposite side of the board and to use insulated wire if the wire crosses other conductors.	(4) Dispaly Slide YXH L6-58. NOTE: Stress checking other side of board for components before drilling.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Conductor replacement	2. Display Slide YXH L6-S9.	
a. A conductor which is missing or damaged so badly that it must be replaced. The following procedures are used to repair this type of damage.		
(1) To replace sections of conductors, cut away the badly damaged portion, if present and drill a small hole through the remaining conductor at each end of the break. Do not drill hole through conductors on the opposite side of the board.	(1) Display Slide YXH L6-S10.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Use a jumper wire to replace missing conductor. Insulated wire must be used to prevent shorts if jumper crosses other conductors.	(2) Display Slide YXH L6-S11.	
(3) A completed conductor replacement with the jumper leads clinched and soldered.	(3) Display Slide YXH L6-S12. NOTE: That the replaced section is placed on the opposite side of the board to provide maximum physical strength.	
(a) This type of repair is merely an elongated version of the clinched staple.		
(b) The reliability of the repair may be increased even more by installing an eyelet in the drilled holes.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. A last resort method of replacing conductors known as "haywiring"	b. Display Slide YXH L6-S13. NOTE: "Haywiring Repair"	
(1) If it is not possible to drill through the board because of conductors on the other side, the entire conductor may be removed and a jumper wire soldered directly to straight-through component leads.		
(2) Technique is very difficult to use if conductor connects more than two components.		
(3) Technique should be used only as a last resort when other replacement techniques cannot be applied since it reduces component mounting strength and must be disassembled to remove components.	(3) Display Slide YXH L6-S14.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Technique for replacing missing pads.	c. Display Slide YXH L6-S15.	
(1) Obtain a replacement pad from a scrap circuit board.		
(2) Reinforce the pad by installing an eyelet.		
(3) Lap solder the pad to the run.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) For maximum reliability, the conductor edges should be beveled before soldering and the replacement pad epoxied to the board prior to soldering and eyeletting. As an alternate to beveling, a matching spacer pad may be positioned on the board and the replacement pad lap soldered to both it and the conductor run after eyeletting.		
3. Conductor bonding		
a. Delamianted conductors resulting from improper repair techniques.	a. Display Slide YXH L6-S16.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Proper method of rebonding delaminated conductors to board surface.	b. Display Slide YXH L6-S17.	
(1) Mix a small amount of epoxy and apply it to the conductor and the conductor path, leaving no uncoated areas.		
(2) Clamp conductor firmly against board surface until epoxy has completely cured.		
(3) If lifted area is at end of conductor, it may be eyeletted immediately after epoxy is applied.		

655

654

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
F. Tools used in printed circuit run and pad repair		
1. Handtools		
a. X-Acto knife		
b. C clamp		
c. Tweezers		
d. Circuit board holder		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. Vise		
f. Mixing slab		
g. Spatula		
h. Bristle brush		
2. Power tools		
a. Rotary tool kit		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Abrasive cutting and grinding bit set.		
c. Drill press		
d. Variac		
e. Curing oven, if available		
f. Soldering iron		
3. Materials		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Wire		
b. Solvent		
c. Kimwipes		
d. Epoxy		
e. Flux		
f. Solder		
g. Scrap circuit boards		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
G. Techniques for replacing damaged printed circuit eyelets.		
1. Selecting	1. Display Slide YXH L6-S18.	
a. The eyelet must be approximately 1/32 inch longer than the board thickness.		
b. The eyelet hole must be just large enough to allow the lead to pass through it freely without binding.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Drilling	2. NOTE: Drill press should be used with CARE.	
a. A drill bit must be selected which will make a hole just large enough for the selected eyelet to fit in snugly.		
b. Do not use excessive force when drilling the hole as it may damage the board.		
c. The hole must not be drilled at an angle.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. When replacing an eyelet where one previously existed, the drill bit should be the same size as the original hole and the eyelet should be picked to fit the hole size.		
e. When drilling to install an eyelet where none previously existed, be sure to examine both sides of the board and determine that no conductor damage or shorting will be caused by the eyelet installation.		
3. Setting		
a. The first step in setting an eyelet is to brace the preformed head of the eyelet against a flat, solid surface such as a jeweler anvil.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The unformed end of the eyelet is then flared to an approximate 45-degree angle by punching the end ONE time with an adjustable, spring-loaded, automatic center punch.		
c. The punch is adjusted for proper striking force by setting a practice eyelet on a scrap circuit board.		
d. The flared end is set flat by tapping a flat pin punch GENTLY against the flared end with a soft-faced hammer. A single tap should be sufficient to properly set the eyelet.		
4. Soldering		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. After setting, the eyelet should be soldered to the circuit conductors for highest reliability.		
b. If a lead or wire is to be soldered through the eyelet, the lead and eyelet should both be soldered in a single operation.		
H. Tools used to install printed circuit eyelets.		
1. Handtools	1. Display Slide YXH L6-S19.	
a. Tweezers		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Automatic center punch		
c. Pin punch		
d. Jeweler anvil		
e. Soft-faced hammer		
2. Power tools		
a. Drill press		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Rotary tool kit		
c. Abrasive grinding and cutting bit set.		
d. Variac		
e. Soldering iron		
3. Materials		
a. Eyelets		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Solvent		
c. Kimwipes		
d. Flux		
e. Solder		
I. Evaluating damaged printed circuit boards to determine extent of repair necessary and repair techniques to be used.		
1. Determining board construction.	1. Display Slide YXH L6-520.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. The following major characteristics must be properly evaluated to determine the overall construction of a circuit board:		
(1) Type of circuit baseboard material.		
(2) Circuit conductor style.		
(3) Component types.		
(4) Component mounting style.		
(5) Type of lead termination.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) Type of interfacial connection		
(7) Solder-joint type		
(8) Type of conformal coating		
b. Board style in use extensively today:	b. Display Slide YXH L6-S21 and point out the characteristics.	
(1) The baseboard material is type G-10 epoxy-glass which consists of thin layers of fiber glass laminated together with epoxy.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) This is currently the most widely used baseboard material. Note the drab green color and weave of the fiber glass.		
(3) Other assembly characteristics are double-sided circuits, gold-plated conductors and flush-mounted discrete components.		
c. Variety of modules used by IBM:	c. Display Slide YXH L6-522.	
(1) Tan modules are single-sided circuits with flush-mounted discrete components mounted on a paper phenolic baseboard.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Phenolic baseboards are either pressed laminated of resin-saturated linen (XXXL) or a pressed laminate of resin-saturated paper (XXXP).		
(3) The two very small modules demonstrate "Cordwood" mounting style.		
(4) Dark colored modules are from the 360 computer. They have multilayer conductors with plated-through holes.		
(5) Silver submodules on boards are multilead, RTV-potted, hermetically-sealed, ceramic substrate printed circuits.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Heat-controlled crystal oven with an insulating cover.	d. Display Slide YXH L6-S23.	
e. Typical submodules	e. Display Slide YXH L6-S24.	
(1) Note the various lead configuarations, dual-in-line and circular-in-line.		
(2) Black modules are unused shells which are assembled by soldering or welding components and then potting.		
f. Submodules mounted on a component board.	f. Display Slide YXH L6-S25.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Components are vertically mounted with one end termination going to a multi-connection solder cup standoff.		
(2) Eyelets are used for interfacial connections.		
(3) Baseboard is epoxy-glass. The light tan color indicates a flame retardant (FR) variety.		
g. Submodules, vertically mounted on a "mother board" which has double-sided circuitry.	g. Display Slide YXH L6-S26.	

690

691

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
h. Example of gold amalgamation of a double-sided board with gold-plated conductors.	h. Display Slide YXH L6-S27.	
(1) Frosty appearance of solder is gold amalgamation.		
(2) Gold should be removed before soldering for highest reliability connections.		
(3) Conductive high carbon content ink was accidently used to silk screen identification marking onto this board. The result was a series of malfunctioning boards.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
i. Transistor mounted through the board in drilled holes. The module was conformal coated with eqpoxy after assembly.	i. Display Slide YXH L6-S28.	
j. Hybrid using vacuum tubes in combination with transistorized submodules built into the special tube bases.	j. Display Slide YXH L6-S29.	
(1) Board material is XXXP phenolic.		
(2) The hand set eyelets and tablets caused the board to crack from tight swedging and board expansion due to heat generated by vacuum tubes.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
k. Capacitors mounted between turret terminals	k. Display Slide YXH L6-530. NOTE: The unusual style of welds on the capacitor leads.	
(1) Lead material forming capacitor plates is also brought through the glass end seal, since it has the same temperature expansion characteristics as the glass and will not cause the seal to break.		
(2) The special lead material is not solderable, thus a solderable lead must be welded to it so that the component may be soldered into the circuit.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Normal welding style is a butt weld versus the lap weld shown.		
(4) The baseboard material in this case is linen phenolic (XXXL).		
1. Method of manufacturing printed circuit baseboard laminates.	1. Display Slide YXH L6-531.	
(1) Epoxy-glass substrate layers laminated together with and outer layer of copper on one or both sides to form single-or double-sided circuit boards.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) The lamination bond is formed under high heat and pressure during the epoxy cure cycle.		
m. The four most common board thicknesses: 1/32-, 1/16-, 1/8- inch.	m. Display Slide YXH L6-532.	
(1) The thickness of board used is determined by the bulk and weight of the components to be used.		
(2) The most commonly used thickness in todays circuitry is the 1/16-inch board.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
n. Examples of standard conductor thicknesses used on printed circuit boards. There are four commonly used thicknesses.	n. Display Slide YXH L6-533.	
(1) 1 ounce - 0.0014 inch or 1.4 mils.		
(2) 2 ounces - 0.0028 inch or 2.8 mils.		
(3) 3 ounces - 0.0042 inch or 4.2 mils.		
(4) 4 ounces - 0.0056 inch or 5.6 mils.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) The weight designation is obtained form weighing 1 ft^2 of the copper material prior to any plating.		
o. Step-by-step process of photo-etching conductor designs on a circuit board.	o. Display Slide YXH L6-634.	
(1) Mask the photosensitive etchant resist film and expose the conductor areas.		
(2) Develop the photosensitive film. The exposed area will become resistant to a solvent wash solution.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Place in solvent bath wihich will remove the unexposed resist films.		
(4) Place the board in an etching solution which will remove all copper not covered by the resist film.		
(5) Solvent rinse to remove all etchant solution and the resist material which remains on the conductor pattern to complete the board.		
p. Step-by-step process of silk screen etching conductor designs on a circuit board.	p. Display Slide YXH L6-S35.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Apply an etchant resist film to the conductor pattern areas through a silk screen mask.		
(2) Place the board in an etching solution which will remove all copper not covered by the screened on film.		
(3) Wash the etchant solution from the completed board.		
q. Circuit board with large ground plane which also serves as a heat sink.	q. Display Slide YXH L6-636.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
r. A closeup showing solder joints to ground plane.	r. Display Slide YXH L6-S37.	
(1) Etched slots in ground plane are for weight reduction and stress relief.		
(2) They also serve to prevent heat blistering under the copper during soldering.		
s. Reverse side of module which has defective solder joints.	s. Display Slide YXH L6-S38.	
(1) Not the pinholes in some of the solder.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Pinholes which are the result of incomplete solder flow are caused by out-gasing of wet flux in holes or holes too large for component leads.		
t. Typical solder connections	t. Display Slide YXH L6-S39.	
(1) Left - full clinched lead termination.		
(2) Right - straight-through lead termination.		
u. Various types of solderable terminals:	u. Display Slide YXH L6-S40.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Turret style		
(2) Hook style		
(3) Eyelet or tab style		
(4) Bifurcated style		
(5) Solder cup style (these are the same as solder cup connector pins)		
v. Shown are typical terminals mounted on liner phenolic (XXXL) boards.	v. Display Slide YXH L6-541.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Turret terminals		
(2) Bifurcated terminals		
(3) Castellated terminals		
w. Various sized terminals which are used to mount different sized components.	w. Display Slide YXH L6-S42.	
(1) Large terminals with large components and small components on small terminals.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Note the leads formed with slack for stress relief at component to lead junctions.		
x. Board using hollow standoffs for multilead connections of vertically mounted components.	x. Display Slide YXH L6-S43.	
y. Typical circuit board edge connector with mating receptacle.	y. Display Slide YXH L6-S44.	
z. A beveled edge on an edge connector, where plug-in takes place. The bevel is to reduce abrasion on receptacle and prevent peel-back of pin on board.	z. Display Slide YXH L6-S45.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
aa. An edge connector mated with its receptacle.	aa. Display Slide YXH L6-S46.	
bb. Various pin-type connectors.	bb. Display Slide YXH L6-S47, NOTE: Keying technique to mating receptacles.	
cc. A typical pin connector installed on circuit board.	cc. Display Slide YXH L6-S48.	
dd. A round pin-type board connector. Note that the flattened, punched end for wire hook-up (on the other end of the plug) is not visible in this slide.	dd. Display Slide YXH L6-S49.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
ee. Board connector using flat pins	ee. Display Slide YXH L6-S50. NOTE: The discoloration on pins.	
(1) The discoloration (silver sulphide) is caused by silver migration through the gold plating on top of silver.		
(2) Silver under gold is forbidden by MIL-STD-275B.		
ff. Fork-type board connector.	ff. Display Slide YXH L6-S51.	
(1) Top illustraiton spring-tension mating.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Bottom illustration - mounting configurations and swaging to printed circuit boards.		
(3) Individual contacts can be replaced, but the swaging makes the job difficult.		
gg. Fork connectors installed on a printed circuit board.	gg. Display Slide YXH L6-S52.	
hh. For connectors swaged to the circuit board.	hh. Display Slide YXH L6-S53.	
ii. Bonding of a single heavy component to a printed circuit board for mechanical strength and shock absorption.	ii. Display Slide YXH L6-S54.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Determining extent and type of damage.	2. Display Slide YXH L6-S55.	
a. Type of damage is determined by the portions of the assembly which are affected.		
(1) Component damage only.		
(2) Coating damage		
(3) Conductor damage		
(4) Baseboard damage		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The extent of damage is determined by the nature of the damage to each individual portion of the assembly.		
(1) Coatings may be peeled, burned, charred or dissolved.		
(2) Conductors may be cracked, nicked, delaminated or missing.		
(3) Baseboard may be cracked, broken, delaminated or missing.		
3. Evaluating feasibility of repair.	3. Ask student the answers to generate participation.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Is reliable repair possible with available tools and techniques?		
b. Can board be salvaged at the expense of destroyed components?		
c. Can components be salvaged when the board is not repairable?		
d. Is reliable repair possible at a higher maintenance level (Micro-Miniature Repair Specialist)?		
4. Choosing appropriate repair techniques.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. After completely evaluating the repair task to be performed, establish a step-by-step repair procedure.		
b. Choose available tools and techniques which will most reliably complete each step of the procedure.		
J. Inspection repaired printed circuit boards for completeness and quality of repair.	J. Display Slide YXH L6-S56.	
1. Condition of laminate.		
a. Inspect laminate material for unrepaired damage.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Inspect laminate repairs for quality and relaibility.		
2. Condition of conductors		
a. Inspect conductors for unrepaired damage.		
b. Inspect conductor repairs for quality and reliability.		
3. Condition of eyelets.		
a. Inspect eyelets for unrepaired damage.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Inspect eyelets for repair quality and relaibility.		
K. Safety precautions.		
1. Workpiece	1. Display Slide YXH L6-557.	
a. Never perform any action on the workpiece which will cause damage or degradation.		
b. Handle all workpieces as extremely fragile.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Maintain scrupulous cleanliness at all times.		
2. Tool		
a. Clean and store all tools properly.		
b. When using chemicals beware of skin, eye and internal contact and avoid excessive inhalation of fumes.		
c. Use eye protection when using power tools and when there is a chance of splashing chemicals.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Do not breathe dust particles from cutting and grinding operations.		
e. Avoid any possibility of igniting flammable chemicals or materials.		
L. Demonstration		
a. Circuit board repair.	a. Instructor should demonstrate the proper techniques and use of tools while showing the student how to install eyelets, make run repairs, pad replacement and board laminate repairs. Covered during the lesson.	a. Observe and ask questions if necessary.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPLICATION		
Performance Sheet 2-4-1P	Supervise each student's completion of Performance Sheet 2.4.1P emphasizing safety.	Complete 2-4-1P. Ask questions if procedures are not clear.
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary.		
2. Purpose of summary.		
B. Directions to students.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Questions		
2. Notes		
C. Recap of lesson completed during demonstration.	C. Emphasize safety.	C. Ask questions if material is not clear. Check notes to insure accuracy and completeness.
V. INFORMAL TEST		
There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application".		
VI. ASSIGNMENT		
Read and study 2-4-1N in Student Guide.	Provide students with the homework assignment.	Ask questions if the assignment is unclear. Complete assignment.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Minature/Microminiature Electronic Repair
(2M) Program A-100-0034

Lesson Topic 3.1:
Soldering to Turret Terminals

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 2.25 Hours
Laboratory - 5.00 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
   a. MERP/2M Kit
2. Training Aids
   a. Slides
      (1) YXH L-8-S1 through YXH L-8-S35
3. Training Aids Equipment
   a. Projector, Slide
   b. Screen, Projection, Standard
4. Text
   a. Student's Guide
5. References
   a. MIL-STD-454D
   b. MIL-S-45743C
   c. NHB-53004 (3A)

TERMINAL OBJECTIVES:

Supported entirely by this lesson topic: NONE

Supported partially by this lesson topic:

3.0 CONNECT wires to turret terminals, hook and pierced tab terminals, biforcated terminals and connector pins using the proper tools and soldering techniques following the procedures and to the standards outlined in MIL-STD-454D, MIL-S-45743C and NHB 4300.

ENABLING OBJECTIVES

When the studen completes this lesson topic, he will be able to:

3.1.1 PREPARE turret terminals for soldering by cleaning and tinning following procedures and to the standards outlined in MIL-S-45743C.

3.1.2 PREPARE wires for soldering by stripping, tinning, and bending following the procedures and to the standards outlined in MIL-S-45743C.

3.1.3 CONNECT prepared wires to turret terminals using the proper tools and soldering techniques following the procedures to the standards outlined in MIL-STD-454D, MIL-S-45743C and NIB 5300.4(3A).

CRITERION TEST

The student will be required to perform a minimum of two single and one double entry turret terminal connections using the soldering techniques as outlined in Performance Sheet 3-1-1P and to the standards in MIL-STD-454D and MIL-S45743C.

HOMEWORK

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	Seek to motivate. Tell a good tie-in story if possible.	
C. Effect	C. When following a subject matter topic, do the following:	
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Overview	D. Overview lesson by:	
	1. Stating learning objectives as contained on cover pages to this topic.	
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes.	
	b. Asking questions.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	c. Use of criterion test.	
	3. Invite questions concerning objectives and procedures.	3. Ask questions concerning objectives or procedures if in doubt.
II. PRESENTATION		
A. Types, sizes, and usage of turret terminals.	A. Display slide YXH L8-2	A. Take notes ask questions.
1. Common types and sizes.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Types	a. Explain differences	
(1) Single section.		
(2) Multiple section.		
(3) Those designed to protrude from one side of the mounting surface only.		
(4) Those designed to protrude from both sides of the mounting surface (feed-through types).		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Sizes		
(1) Turret terminals are used in many sizes		
(2) The terminal size and conductor size should correspond.		
(3) The procedure of placing a large component or conductor on a small turret terminal creates undesirable stresses on the terminal which may lead to unreliability of the assembly.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Uses		
a. Turret terminals are used for providing interfacial connections on printed circuit boards.		
b. As terminal points for point-to-point wiring.		
c. For mounting components.		
d. As tie points for interconnecting wiring.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Preparing a Turret Terminal for Soldering	B. Display slide YXH L8-S3	
1. Cleaning		
a. Terminals must be cleaned prior to attaching leads or conductors. Cleaning may be done by:		
(1) Adding, then removing new solder from the tinned surface, thus removing oxides.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) On new, relatively clean terminals, the use of solvent is often sufficient. If not, the above method should be used.		
(3) Old, used, very dirty, or highly oxidized terminals may require repeated solder coating/removal steps and/or abrasion techniques to properly prepare them for soldering.		
b. If terminals must be handled after cleaning operations, a recleaning with solvent is necessary to remove the oils and salts deposited from contact with the skin.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Tinning		
a. Terminals must be tinned prior to soldering. This enhances the flow of solder and aids in the formation of a reliable intermetallic bond.		
b. The solder coating/removal steps involved in the cleaning process provide a good tinned surface.		
c. For tinning a new terminal, the application of flux and fresh solder with the proper heating to cause the solder to wet thoroughly is required.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Preparing Wire for Soldering to Turret Terminals		
1. Tools used		
a. Mechanical and thermal wire strippers		
b. Soldering iron		
c. Antiwicking tools (tweezers, "Little Joes")		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Vise		
e. Round nose pliers		
f. Nylon rod		
g. Flush-cutting pliers		
h. Soldering iron holder		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Stripping		
a. The wire is stripped CAREFULLY, using either an approved style of mechanical wire stripper or the thermal strippers. (chemical stripper for varnish)		
b. Nonapproved wire strippers. Even though this stripper is adjustable, it is not precision enough to prevent damage to the wire. Also, if the wire is pulled through the blades at an angle, scraping or scratching of the wire surface will occur.	b. Display slide YXH L8-S4. Tell why not approved.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Other types such as the combination "wire stripper, crimper, and bolt cutters" are also nonapproved.		
d. Mechanical strippers of the nonadjustable, factory set type should be used when thermal strippers are not available.		
e. Approved type of mechanical wire strippers to be used. These strippers have the nonadjustable, factory set prevision blades to provide reliable stripping without damage when used with CARE.	e. Display slide YXH L8-S5	

4/8

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. These strippers should be inspected frequently to ensure that the blades are sharp and have not becom misaligned.		
g. Mechanical strippers should not be used on wire sized AWG-22 or smaller. The mechanical advantage of the stripper is such that the smaller sizes mentioned may be stretched by the pulling action as the insulation is removed.	g. STRESS why strippers should not be used on wire size AWG-22.	
h. Any damage to the wire caused by stripping is grounds for rejection. The damaged area shall be removed and the wire restripped. (cuts, scrapes, nicks or "birdcaging")		

779

740

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
i. Thermal wire stripper. This is a bench model for production line work. There are many other types of thermal strippers, but all work is by the same melting action to remove the insulation.	i. Display slide YXH L8-S6	
j. Thermal strippers should be used whenever possible as the chance for wire damage is minimized.		
k. Wire is inserted into the jaws of the thermal strippers. Some models have an adjustable stop to provide a repetitive strip length, and some have an adjustment for depth of jaw cut.	k. Display slide XYH L8-7	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
l. In operation, the jaws are closed GENTLY on the wire and power is applied. The wire is then turned approximately 90 degrees when the melting action becomes visually apparent.		
m. When the jaws have melted through the insulation creating a cut completely around the circumference of the wire, the jaws are opened and the wire removed. Note that the action desired is to MELT through the insulation, NOT burn through. Burning will damage the insulation and cause rejection of the wire.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
n. Insulation being removed with the fingers. The insulation must be allowed to turn and follow the lay of the wire strands during this operation to prevent birdcaging of the wire. DO NOT change the rate of twist of the wire in the stripping process.	n. Display slide YXH L8-S8	
o. Results of correct wire stripping. (Note the wire strands are not disturbed)	o. Display slide YXH L8-S9	
p. Chemical stripper used to remove varnish type insulation from magnet wire.	p. Display slide YXH L8-S10	
(1) Dip wire in chemical.		

415

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Allow 3 minutes for softening.		
(3) Use disposable tissue to clean (Kimwipe).		
(4) Neutralize exposed wire with water or solvent.		
q. Results of chemical stripping.	q. Display slid YXH L8-S11	
3. Tinning	3. Display slide YXH L8-S12	

787

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Tinning of the wire is required to prevent damage in the bending operation and to enhance the flow of solder during the soldering operation.		
b. One method of tinning the wire. Note the use of antiwicking tweezers to prevent solder wicking up under the insulation due to capillary action.	b. Explain how to tin wires to meet standards.	
(1) The operation is performed by bringing a clean, dry soldering iron in behind the wire, one third to one half the distance down from the antiwicking device.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Solder is applied at the junction of the iron and the wire, and allowed to soak into the wire.		
(3) The iron and solder are then moved up the wire toward the antiwicking device.		
(4) When the iron and solder reach the antiwicking device, hesitate momentarily and continue to flow in solder, then work back down and off the end of the wire carrying any oxides removed by the flux off the wire.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Alternate method of tinning wire.	c. Display slide YXH L8-S13	
(1) Melt fresh solder on the clean, dry tip.		
(2) Lay wire into molten solder while adding solder to the top of the wire (hold more vertical than shown).		
(3) When the solder is seen to soak into the wire, move the wire in the same manner as in the previous method of tinning, hesitating next to the antiwicking device, then back the wire through the solder until the cut end is reached and then off the iron.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. For best results in tinning, the iron must be at full line voltage. A flat faced tip should be used. 4. Bending a. Any method may be used for bending that does not damage the wire in any way. (1) Round nose pliers (2) Nylon rod		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Dummy terminal		
b. Round nose pliers being use to bend wire. Care must be used with this method to prevent denting or otherwise damaging the wire.	b. Display slide YXH L8-S14	
c. Nylon rod used to bend the wire. It is not necessary to use the antiwicking device and, if not used with extreme care, the device itself may be damaged.	c. Display slid YXH L8-S15	
d. Dummy terminal used to bend the wire. If this method is used on the terminal to be soldered to, damage to the terminal may result.	d. Display slide YXH L8-16.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Turret Terminal Solder Connection Specifications		
1. Wire wrap		
a. In all cases for turret terminals, the minimum wrap around the terminal shall be 180 degrees (one half turn)	a. Display slide YXH L8-S17	
b. Maximum amount of wrap depends on wrie size, as follows:	b. Point out on slide wire wrap specs.	
(1) AWG-26 and smaller may be 360 degrees (one full turn)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) AWG-24 and larger may be 270 degrees (three-fourths turn)		
c. The perferred wire wrap is 180 degrees		
d. A tinned wire bent and cut to specifications. Observe that the wire is properly tinned; you can see the contour of the wire strands, and there is no evidence of nicked conductors or birdcaging. Note that tinning does not extend all the way to the insulation.	d. Display slide XYH L8-S18	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. The size of the bend made shall be such that the bend will fit firmly against the terminal post throughout the wrap, and cover a minimum of 180 degrees.	e. Display slide YXH L8-S19	
f. Wire improperly tinned and bend.	f. Display slide YXH L8-S20	
(1) Uneven bend will not fit firmly against the post portion of the terminal.		
(2) Excessive solder used in tinning; the wire strands not visible, not able to see any damage that may exist under the tinned surface. (nicks or scrapes)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Wire position		
a. Proper position of the wire on the terminal requires that it be set firmly against the post portion of the terminal and that it be set flat on the pad area as viewed both from the front and the side.	a. Display slide YXH L8-S21	
b. Wire holding devices may be used to hold the wire in position and to prevent motion while soldering.		
c. Proper positioning of double wires on a turret terminal.	c. Display slide YXH L8-S22	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Wire positioning requirements are the same for two or more wires as they are for single wire connection with the following additional requirements:		
(1) All wires are wrapped in the sam direction.		
(2) All wires are trimmed to the same lengths.		
(3) Wires are positioned directly one above the other.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. Improper positioning of the wire in that a pair of pliers is being used to squeeze wire against post portion of terminal. This will cause the wire to fit improperly against the post and may damage the wire as follows.	e. Display slide YXH L8-S23	
(1) Smashing of the strands		
(2) Disrupting the tinning inside the wire.		
(3) Nicking or cutting of the wire strands.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. One method of securing the wire prior to soldering.	f. Display slide YXH L8-S24	
g. In field operations any method that will hold the wire may be used such as the use of rubber bands, clips, etc.		
3. Area to be soldered	3. Display slide YXH L8-S25	
a. The area to be soldered consists of the pad portion of the terminal, the post portion of the terminal, and the area of the wire in contact with the terminal.		

811

812

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Where cutting the bent wire leaves copper exposed, the soldering operation must ensure that no copper remains exposed.		
4. Solder quantity		
a. Solder quantity shall be such that all angles formed by the junction of the wire and the terminal will be filled with solder to form a fillet.		
b. Overall flow of solder shall present an appearance of concave fillets extending approximately one half the distance across the wire.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Contour of the wire strands shall be visible.		
d. There shall be no convex appearance to the solder flow on the finished terminal.		
E. Techniques for Making High Quality Turret Terminal Solder Connections		
1. Application of flux		
a. Flux cored solder normally supplies all necessary flux for proper wetting of solder.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. External flux may be used; however, the possibility of causing the solder to wick under the insulation increases greatly.		
2. Proper heat		
a. Proper heating is required to bring the terminal and wire mass RAPIDLY to the melting temperature of solder.		
b. Proper heating is accomplished by using the appriate size tip and the appropriate wattage element for the size of mass involved.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. A solder bridge accomplished rapid transfer of heat from the iron tip to the connection.		
3. Application of solder		
a. For proper application of solder, bring a clean, dry iron into contact with BOTH the terminal and the lead.		
b. Properly positioned the iron to contact both the terminal and the lead, and a heat bridge being established between the iron and the lead with CLEAN solder.	b. Display slide YXH L8-S27	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Solder being applied to form a fillet.	c. Display slide YXH L8-S28	
(1) At this time, place the solder at the end of the wire to tin the exposed copper and also form the fillet between the end of the wire and terminal, as well as the fillet between the start of the wire bend and the terminal where the wire enters the connection.		
(2) This fillet is formed by wiping the solder across the end of the wire and continuing across the pad portion of the terminal and into the angle formed by the incoming wire and the post.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) When the proper amount of solder has been applied, remove the solder and the iron at the SAME time. This will prevent overheating of the solder and result in a smooth, gleaming finish.		
4. Cleaning after soldering		
a. After the solder connection has cooled and the solder has solidified, the connection must be thoroughly cleaned with an approved solvent to remove all traces of flux.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. A bristle brush and solvent being used to remove all traces of flux and any foreigh matter tha may remain on the terminal.	b. Display slide YXH L8-S29	
F. Inspecting Completed Turret Terminal Solder Connections for Quality		
1. Standards of acceptance		
a. Wire being used to gauge the insulation clearance.	a. Display slide YXH L8-S30	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Insulation gap shall be no greater than a distance equal to two times the overall diameter of the wire, including the insulation, measured from the insulation to the edge of the solder flow on the terminal.	b. Explain all standards of acceptance.	
c. The preferred insulation clearance for turret terminals is one overall wire diameter.		
d. Wire shall be confined to the guide slots.		
e. Wire shall be flat on the pad portion of the terminal.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. Bend of wire shall fit snugly against post.		
g. Solder shall have a smooth gleaming finish free from holes, pits, and stress lines.		
h. Solder shall show no evidence of dewetting from the terminal or the lead.		
i. The contour of the wire strands shall be visible and the solder flow shall present concave fillets.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
j. Insulation shall who no signs of overheating such as swelling or discoloration nor shall it be imbedded in the solder joint.		
k. There shall be no wicking of the solder under the insulation. This provides the required flexibility at the connection to prevent vibration and stresses from causing the wire to break at this point.		
l. There shall be no spillage of solder over the sides of the terminal (a thin wetted area is acceptable).		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Indications to look for		
a. Inspection of a turret terminal for quality involves all of the standards of acceptance.		
b. Two views of a completed turret terminal.	b. Display slide YXH L8-S31	
(1) As we inspect this terminal, we can see that the contours of the wire strands are visible; there is also a smooth fillet between the terminal and wire.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) There is no trace of flux or copper showing at the end of the wire, and also the base of the terminal is tinned as it should be.		
3. Reasons for rejection		
a. Many reasons exist for rejection of a turret terminal connection.		
b. An unreliable, rejected connection.	b. Display slide YXH L8-S32	
(1) Broken wire strands.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Discolored insulation.		
(3) Wire not properly postioned on terminal.		
(4) Overheated solder.		
(5) Disturbed solder		
(6) Wicking		
(7) Scrapped spot on the terminal		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Another unreliable connection.	c. Display slide YXH L8-S33	
(1) Pits in the solder.		
(2) Wicking (insulation cut away to show extent).		
(3) Dewetting.		
(4) Nicked strand (between insulation and terminal).		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
G. Safety Precautions	G. Display slide YXH L8-S34	
1. Work piece		
(a) Same as rest of lessons		
2. Tool		
(a) Same as rest of lessons		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Personal		
NOTE: Teflon releases toxic fumes at 400 degrees F. Be expecially careful when stripping wire as the element exceeds 400 degrees F and will cause fuming of Telefon insulation.		
III. APPLICATION		
Performance Sheet 3-1-1P	Supervise each student's completion of - - -, emphasizing safety; soldering performance.	Complete Performance Sheet. Ask questions if procedures are not clear.
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Nature of summary.		
2. Purpose of summary.		
B. Directions to students.		
1. Questions		
2. Notes		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Recap of lesson	C. Emphasize safe	C. Ask questions if material not clear; check notes to insure accuracy and completeness.
V. INFORMAL TEST There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application."		
VI. ASSIGNMENT	VI. Provide students with homework assignment.	VI. Ask questions if the assignment is unclear. Complete assignment.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminature Electronic Repair (2M) Program A1000034

Security Classification: UNCLASSIFED

Lesson Topic 3.2:
Soldering to Hook and Pierced Tab Terminals

Time Allocation: Classroom 1.75 Hours
Laboratory 5.0 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
    a. MERP/2M Kit
2. Training Aids
    a. Slides YXH L9-S1 thru YXH L9-S28
3. Training Aids Equipment
    a. Projector, Slide
    b. Screen, Projector, Standard
4. Text
    a. Student's Guide
5. References
    a. MIL-STD-454D
    b. NHB-5300.4 (3A)
    c. NASA SP-5002

TERMINAL OBJECTIVE:

Supported partially by this lesson topic:

5.0 CONNECT wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connector pins using the proper tools and soldering techniques following the procedures and to the standards outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4 (3A).

ENABLING OBJECTIVES:

When you complete this lesson topic, you will be able to:

3.2.1 PREPARE hook and tab terminals for soldering by cleaning and tinning following procedures and to the standards outlined in MIL-S-45743C.

3.2.2 PREPARE wires for soldering by stripping and tinning following the procedures and to the standards outlined in MIL-S-45743C.

3.2.3 CONNECT prepared wires to hook and pierced tab terminals using the proper tools and soldering techniques following the procedures and to the standards outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4 (3A).

CRITERION TEST

Given selected hook and pierced tab terminals the student will be required to prepare the terminals and necessary wire for soldering and then connect the wires to the terminals completing a minimum of two single and one double connection on each terminal style in accordance with the procedures and to the standards outlined in Performance Sheet 3-2-1P.

HOMEWORK

Read and study Notetaking Sheet 3-2-1N.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs.	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills.	
	4. Seek to motivate. Tell a good tie-in story if possible.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Effect	C. When following a subject matter lesson topic, do the following:	
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	
D. Overview	D. Overview lesson by:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Stating learning objectives as contained on cover pages to this topic.	
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes	
	b. Asking questions	
	c. Use of criterion test	

858

850

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	3. Invite questions concerning objectives	3. Ask questions concerning objectives or procedures if in doubt.
II. **PRESENTATION**		
A. Types, sizes and usage of hook and tab terminals.	A. Explain and describe the types and sizes of hooks tab terminals while projecting slides.	
1. Common types and sizes	1. Display slide YXH L9-S2	1. Students take notes and ask questions
a. Types		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Hook (question mark style)		
(2) Hook ("J" shape)		
(3) Tab (pierced tab eyelet)		
b. Sizes		
(1) Many sizes are used depending on current-flow requirements of the device.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Terminal size and wire size should correspond.		
2. Uses		
a. Hook and tab terminals are used to provide connection points on sealed devices and terminal boards.		
b. Tab terminals are usually connection points on the rear of edge connector receptical pins.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. When this type of terminal is used, the connections are normally made in an end-on manner to the device.		
B. Preparing hook and tab terminals for soldering.	B. Display Slide YXH L9-S3	
1. Cleaning		
a. Terminals must be cleaned prior to attaching leads or connectors by:		
(1) Adding new solder and removing excess in order to tin surface and remove oxides.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) On new untarnished terminals, the use of solvent alone for cleaning is often sufficient.		
b. If terminals are handled during joint preparation, they must be recleaned with solvent as a final step prior to soldering.		
2. Tinning		
a. Used or tarnished terminals should always be tinned prior to soldering.		
b. The tinning process enhances solder flow on the connection and cleans oxides from the terminal.		

456

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Preparing wire for soldering to hook and tab terminals.	C. Display Slide YXH L9-S4	
1. Tools used		
a. Mechanical and/or thermal wire strippers.		
b. Soldering iron		
c. Antiwicking devices		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Vice		
e. Round nose pliers		
f. Nylon rod		
g. Flush-cutting pliers		
2. Stripping		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Same techniques and procedures as those taught for wire preparation when soldering turret terminals.		
3. Tinning		
a. Same techniques and procedures as those taught for wire preparation when soldering turret terminals.		
4. Bending		
a. Any method may be used for bending wire that does not damage the wire in any way.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Round nose pliers		
(2) Nylon rod		
(3) Dummy terminal		
b. Care must be taken not to crush, overstress, or birdcage the wire during the bending operation.		
D. Hook and tab terminal solder connection specifications.		
1. Wire wrap	1. Display Slide YXH L9-S5	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. In all cases, for hook and tab style connections, the minimum wrap around the terminal shall be 90 degrees (1/4 turn)		
b. The maximum wrap shall be no more than 270 degrees (3/4 turn)		
c. For tab type terminal connections the recommended wire wrap is 180 degrees. The wire should be flush-cut, after bending at 180 degrees.	c. Display Slide YXH L9-S6 Stress 180 degrees preferred for pierced tab	
d. For hook or "J" type terminal connections the recommended wrap is 120 degrees. The wire should flush-cut after bending at 120 degrees.	d. Display Slide YXH L9-S7 "Stress 120 degrees to 160 degrees for hook type	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. The cut for 120 degrees is not straight across the wire but angled to form a flush surface with the side of the terminal when installed.	e. Display Slide YXH L9-S8	
2. Wire position		
a. Proper position of wire on hook terminals requires that it be firmly in contact with the terminal mounting surface.	a. Display Slide YXH L9-S9	
b. Connection to a hook terminal. Near maximum wrap is used rather than the optimum. This wrap is not preferred since it makes the wire difficult to remove.	b. Display Slide YXH L9-S10	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. A properly positioned wire on a tab terminal. Wire does not have to enter vertically to the mounting surface on tab style terminals in that the preferred 18 degree wrap is being used.	c. Display Slide YXH L9-S11 Stress this point.	
d. Wire position requirements for for double or multiple wires on hook terminals are the same as for single wire connections with the following additional requirements.	d. Display Slide YXH L9-S12	
(1) The wires wrap around the terminal in alternating directions. This equalizes stresses and protects the glass seal at the base of the terminal from damage.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) All wires approach the terminal from the same direction (angle)		
(3) The wires normally attach side side-by-side on the terminal. If the terminal size. wire size. or number of wires dictate. a piggyback (one wire directly on top of another) mounting style is permissible but care must be taken to adjust the diameter of wire bends accordingly.	(3) Stress side by side or piggy back technique.	
e. Method of holding wires for hook and tab terminals in the proper soldering position.	e. Display Slide YXH L9-S13	
3. Area to be soldered	3. Display Slide YXH L9-S14	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. The area to be soldered consists of the portion of the terminal and wire that are in contact with each other.	a. Stress	
b. Smooth fillets must be formed between the wire and terminal at all areas of contact.		
c. There must be no copper exposed on the cut end of the wire.		
4. Solder quantity		
a. Solder fillets must be formed at all points of contact between the wire and the lead and all fillets must be concave.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. There must be no excessive solder flow to other areas of the terminal.		
c. Solder quantity must be such that contours of wire and individual wire strands are clearly visible.		
E. Tools used to make hook and tab solder connections.		
1. Handtools	1. Remind students that tools are the same as used previously.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
F. Techniques for making high quality hook and tab solder connections.	F. Display Slide YXH_L9-S15	
1. Application of flux		
a. Flux contained within the solder is normally sufficient for soldering a properly cleaned and prepared connection.		
b. External flux may be used if desired however, its use greatly increases chances of solder wicking up under the insulation.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Proper heat		
a. Proper heating source is determined by choosing a tip size and element wattage appropriate to the mass being soldered. Use the variable power control to set temperature at the desired level.		
b. Proper heat flow is established by using a clean, dry iron and forming a heat bridge.		
3. Applicaiton of solder		
a. For proper application of solder, bring a clean, dry iron into contact with the terminal and the wire.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The iron in proper contact to both the terminal and the wire and the heat bridge being established at the junction of the iron and the wire.	b. Display Slide YXH L9-S16	
	NOTE: The iron tip aids in maintaining wire position.	
c. Method of establishing a heat bridge on termianls with more than one wire attached.	c. Display Slide YXH L9-S17	
(1) Alternating direction of the wire wrap.	1. Stress	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) All wires approach terminal from the same direction and attach to terminal side-by-side.	(2) Stress	
(3) Caution must be used not to misalign wire position with soldering iron tip.	(3) Stress	
d. The proper method of applying solder to a single wire connection	d. Display Slide YXH L9-S18	
(1) First, tin-cut end thoroughly		
(2) Flow in sufficient solder to form fillets. Note that a very small amount of solder is required to complete this type connection.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Remove iron and solder at the SAME time.		
e. Proper method of applying solder to a multiple wire connection.	e. Display Slide YXH L9-S19	
(1) First, tin cut ends of ALL cut wires in the connection (on piggyback style, capillary action will tin hidden end).		
(2) Add sufficient solder to form fillets.		
(3) Remove iron and solder at the SAME time.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Cleaning after soldering.		
a. Thorough cleaning after soldering is always required.	a. Display Slide YXH L9-620	
b. Cleanliness must also be practiced during soldering.	b. Display Slide YXH L9-621 Note the grossly exaggerated example of poor soldering.	
G. Inspecting completed hook and eyelet terminal solder connections for quality.		
1. Standards of acceptance		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Typical hook and tab connnection.	a. Display Slide YXH L9-522	
(1) The correctness of insulation clearance (hook and eyelet terminals use the same insulation clearance as turret termianls)	(1) Stress all points	
(2) Wire wrap (greater than preferred)		
(3) Solder fillets		
(4) Wire entry angle		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Indications	2. Display Slide YXH L9-S23	
a. Single wire hook terminals	a. Stress below points	
(1) Smooth, gleaming with no pits		
(2) Concave solder fillets in proper places.		
(3) Bare wire outside of solder connection remains flexible.		
(4) No bare copper showing		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Proper wire wrap		
(6) Wire and strand contours visible		
(7) Proper insulation clearance		
b. Multiple wire hook terminals.	b. Display Slide YXH L9-S24	
(1) Multiple wire connections are inspected for all points given for single wire connections.	(1) Stress	
(2) Alternating direction of wire wraps.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Completed tab terminal connection which is inspected for the same points as the hook terminal connections.	c. Display Slide YHX L9-S25	
d. Pierced tab style connection.	d. Display Slide YHX L9-S26 It is also inspected for the same points as the hook terminal connections.	
3. Reasons for rejection.	3. Stress reasons for rejection.	
a. Wire damage in any manner		
b. Solder sicking up wire and under insulation.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Improper solder quantity		
d. Poor wetting action		
e. Improper wire positioning and wrap		
f. Any copper showing		
H. Safety precautions	H. Display Slide YXH L9-S27 Mention the precautions are the same as previously presented and that they should be observed throughout the course.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Workpiece		
a. Same		
2. Tool		
a. Same		
3. Personal	3. Stress this point	
a. Beware of the poisonous fumes from Telfon during the stripping and soldering operations.		

OUTLINE OF INSTRUCTION	INSTRUCTOR'S ACTIVITY	STUDENT'S ACTIVITY
I. Demonstration		
1. Hook and Pierced Tab Terminal Soldering	1. Instructor should demonstrate the accepted techniques and use of the proper tools while connecting wires to Hook and Pierced Tab Terminals by soldering. Both single and double connections should be demonstrated. Introduce Performance Sheet 3-2-1P.	1. Observe demonstration and ask questions as necessary.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPLICATION		
A. Performance Sheet 3.2.1P	A. Supervise each student's completion of Performance Sheet - -, emphasizing safety.	A. Complete performance Sheet 3.2.1. Ask questions if procedure are not clear.
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of Summary		
2. Purpose of Summary		
B. Directions to Students		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Questions		
2. Notes		
C. Recap of lesson is conducted during demonstration by instructor	C. Emphasize safety	C. Ask questions if mate not clear; check note to insure accuracy an completeness.
V. INFORMAL TEST		
A. There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application".		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
VI. ASSIGNMENT		
A. Notetaking Sheet 3.2.1N	A. Provide student with the homework assignment.	A. Ask questions if the assignment is unclear. Complete assignment by reading and studying 3.2.1N.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program
A-100-0034

Lesson Topic 3.3:
Soldering to Bifurcated Terminals

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 1.75 Hours
Laboratory - 5.5 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
    a. MERP/2M Kit
2. Training Aids
    a. Slides
        (1) YXH L-10-S1 through YXH-L10-S34
3. Training Aids Equipment
    a. Projector, slide
    b. Screen, Projector, standard
4. Text
    a. Student's Guide
5. References
    a. MIL-STD-454D
    b. MIL-S-45743C
    c. NHB 5300.4(3A)

TERMINAL OBJECTIVES

Supported partially by this lesson topic:

5.0 CONNECT wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connector pins using the proper tools and soldering techniques following the procedures and to the standards outlined in MIL-STD-454D, MIL-S-45743C an NHB 5300.4(3A)

ENABLING OBJECTIVES

When you complete this lesson topic you will be able to:

3.3.1 PREPARE bifurcated terminals for soldering by cleaning and tinning following procedures and to the standards outlined in MIL-S-45743C.

3.3.2 PREPARE wires for soldering by tinning and ben following the procedures and to the standard outlined in MIL-S-45743C.

3.3.3 CONNECT prepared wires to bifurcated terminals using the proper tools and soldering technique following the procedures and to the standards outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4(3A).

CRITERION TEST

The student will be required to perform a minimum of one connection on each bifurcated terminal, completing the single entry, double entry, top entry and bottom entry connections using the soldering techniques as outlined in Performance sheet 3.3.1P and to the standards in MIL-STD-454D and MIL-S-45743C.

HOMEWORK

Read and study Notetaking Sheet 3-3-1N.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for student needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship	
	2. The necessity of the skills and techniques in repair of printed circuit boards	
	3. Personal applications of the knowledge and skills. Seek to motivate. Tell a good tie-in story if possible.	
C. Effect	C. When following a subject matter lesson topic, do the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	
D. Overview	D. Overview lesson by:	
	1. Stating learning objectives as contained on cover pages to this topic.	
	2. Stating procedures to be followed during the lesson.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	a. Taking notes	
	b. Asking questions	
	c. Use of criterion test	
	3. Invite questions concerning objectives and procedures.	3. Ask questions concern objectives or procedures if in doubt
II. PRESENTATION		
A. Types, sizes and usage of bifurcated terminals	A. Explain type, size and usage of bifurcated terminals.	A. Take notes. Ask questions.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Common types and sizes		
a. Types - Variety of terminals of the bifurcated type (any terminal which has a split or a fork).		
b. Sizes	b. Display Slide YXH L10-S2	
(1) Many sizes are used depending on the current-flow requirements.		
2. Uses		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Bifurcated terminals are used to solder many wires to a single point		
b. High stress and current flow		
B. Preparing bifurcated terminals for soldering	B. Display Slide YXH L10-S3	
1. Cleaning		
a. Terminals must be cleaned prior to attaching leads or conductors		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Adding new solder and removing excess.		
(2) On new, untarnished terminals the use of solvent alone for cleaning is often sufficient.		
b. If terminals are handled during joint preparation, they must be recleaned with solvent.		
2. Tinning		
a. Used or tarnished terminals should always be tinned prior to soldering.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The tinning process enhances solder flow on the connection and cleans oxides from the terminal.		
C. Preparing wire for soldering to bifurcated terminals	C. Display Slide YXH L10-S4	
1. Tools used	1. Introduce only new tools to students	
a. Mechanical and/or thermal wire strippers		
b. Soldering iron		
c. Antiwicking devices		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Vise		
e. Round nose pliers		
f. Needle nose pliers		
g. Orange wood stick		
h. Flush-cutting pliers		
2. Stripping - same techniques and procedures as taught for wire preparation when soldering turret terminals.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Tinning - same techniques and procedures as those taught for wire preparation when soldering turret terminals		
4. Bending		
a. Any method may be used for bending wire that does not damage the wire in any way	a. Explain bending techniques	
(1) Needle nose pliers		
(2) Nylon rod		
(3) Dummy terminal		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Care must be taken not to crush, overstress or birdcage the wire during the bending operation	b. Stress this	
D. Bifurcated terminal solder connection specifications	D. Explain specifications	
1. Wire wrap		
a. Three different wire wrap specifications to be considered in bifurcated terminal connections.		
(1) Wire wrap for side entry connections shall be exactly 90 degrees	(1) Display Slide YXH L10-S5	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Wire bent to 90 degrees and is cut with flush-cutting pliers. The sharp square bend is made using flat-jawed pliers such as needle nose.	(2) Display Slide YXH L10-S6	
(3) Alternate method - sharp 90 degree bend using a dummy terminal	(3) Display Slide YXH L10-S7	
(4) Wire is bent and properly cut for making a side entry bifurcated terminal connection	(4) Display Slide YXH L10-S8	
b. Bottom entry wire wrap		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) The only practical method of bending the wire for a bottom entry connection is by using the terminal as a bending form, since a bent wire cannot be inserted through the bottom of the terminal	(1) Display Slide UXH L10-S9	
(2) The bend for this connection must be exactly 90 degrees; however, it is not necessary to make the corner of the bend as sharp as for a side entry		
(3) The wire for the bottom entry connection is cut flush with the edge of the terminal base. The same is true for the side entry connection.	(3) Display Slide YXH L10-S10	

498

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Top entry connection		
(1) The wire in a top entry connection is not wrapped but, if smaller than the space between the terminal ears, is pressed in with a filler wire of the correct size to provide a snug fit between the ears.	(1) Display Slide YXH L10-S11	
(2) The bottom end of the filler wire must be even with the surface of the base, and the top must be cut flush with the top edge of the terminal ears.	(2) Display Slide YXH L10-S12	
(3) Great care must be used when cutting the filler wire not to cause damage to the wire being brought into the terminal		

952

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Wire position		
a. The side entry single wire connection positioning specifications.	a. Display Slide YXH L10-S13	
(1) The wire is in contact with the surface of the terminal base as seen from front and side views		
(2) The wire wraps around one ear of the terminal and is in contact with the inside edge and one side of that ear		
(3) The wire end is flush-cut and does NOT overhang the edge of the terminal		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The side entry multiple wire connection has the same positioning as the single wire side entry with the following additional requirements:	b. Display Slide YXH L10-S14 and explain double wire positioning	
(1) Additional wires are wrapped in an alternating pattern.		
(2) Wires other than the bottom wire must contact the terminal ear as specified for single connections but will not contact the terminal base.		
(3) All wires enter the terminal from the same side and must be parallel to each other.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. The bottom entry connection positioning specifications.	c. Display Slide YXH L10-S15	
(1) The wire must be in contact with the surface of the terminal base from the edge of the hole out to the edge of the base.		
(2) The wire must be cut flush with the edge of the base and must not overhang.		
(3) The wire should lie on a line drawn straight through the gap between the ears of the terminal		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. The top entry connection has the following positioning specifications.	d. Display Slide YXH L10-S17	
(1) The cut end of the wire shall be level with the surface of the terminal base		
(2) The wire shall be exactly in line with the hole through the base of the terminal		
e. Insulation clearance for all styles of bifurcated terminal connections shall be the same as that given for previous terminals	e. Explain area to be soldered	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Area to be soldered		
a. The entire surface of the base must be tinned.		
b. Smooth fillets must be formed between the wire and the terminal at all areas of contact.		
c. There must be no copper showing on cut wire ends.		
d. In all cases, solder must be flowed entirely over the hole through the base of the terminal, but no solder may flow through the hole beyond the bottom edge of the terminal base.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Solder quantity		
a. All solder fillets must be concave.		
b. There must be no solder on any portion of the terminal other than those given as areas to be soldered.		
c. Contours of wires and individual strands must be visible.		
E. Techniques for making high quality bifurcated terminal solder connections	E. Display Slide YXH L10-S18	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Application of flux		
a. Flux contained within the solder is normally sufficient for soldering a properly cleaned and prepared connection.		
b. External flux may be used if desired; however, its use greatly increases the chance of solder wicking up under the insulation.		
2. Proper heat		
a. Proper heating source is determined by choosing a tip size and element wattage appropriate to the mass being soldered. Use the variable power control to set temperature at the desired level.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Proper heat flow is established by using a clean, dry iron and forming a heat bridge.		
3. Application of solder		
a. For proper application of solder, bring a clean, dry iron into contact with the terminal and the wire.		
b. For each bifurcated terminal connection style, there is a separate technique for applying solder.		
c. The solder application technique for side entry connections with a single wire is as follows.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Establish the heat bridge for a side entry connection.	(1) Display Slide YXH L10-S19	
(2) Thoroughly tin the surface of the base of the terminal and the cut end of the wire.	(2) Display Slide YXH L10-S20	
(3) REMOVE THE IRON and CONTINUE to flow solder into the hole area of the terminal (using residual heat of terminal to melt solder) until the hole is completely covered with solder.	(3) Explain this technique well, ensuring each student understands it. . . This will only work if the iron is removed and must be finished before the terminal cools below the solder melting point.	
d. The solder application technique for multiple entry connections		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Establish the heat bridge for a multiple side entry connection	(1) Display Slide YXH L10-S21	
(2) Thoroughly tin the base of the terminal, remembering that there is more than one cut wire end to be tinned.	(2) Display Slide YXH L10-S22	
(3) Cover the hole area with solder again, using the same techniques used with single wire side entry connections.		
e. The solder application technique for top entry connections		
(1) Establish the heat bridge for a top entry connection	(1) Display Slide YXH L10-S23	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) The base is tinned as with previous connection styles		
(3) Cover the hole again	(3) Display Slide YXH L10-S24	
f. The solder application technique for bottom entry connections is as follows.		
(1) Establish the heat bridge for a bottom entry connection	(1) Slide YXH L10-S25	
(2) Tinning the base and forming the fillets for a bottom entry connection	(2) Display Slide YXH L10-S26	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) The hole is sealed with solder as in previous connection methods		
4. Cleaning after soldering	4. Display Slide YXH L10-S27	
a. A thorough cleaning must be given the connection after soldering	a. Stress this point	
b. Cleaning is accomplished as described previously		
F. Inspecting completed bifurcated terminal solder connections for quality	F. Display Slide YXH L10-S28 "Inspecting Bifurcated Terminal Connections"	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Standards of acceptance		
a. The following points must be examined and determined to be within specifications:		
(1) Proper wire wraps		
(2) Correct wire position		
(3) Solder in all required areas		
(4) Proper solder quantity		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) No solder defects		
2. Indications to look for	2. Explain what to look for in each bifurcated terminal connection, Style.	
a. Each style of bifurcated terminal has its own indications of quality		
b. The indications for single wire side entry connections are as follows:		
(1) Solder, smooth, and gleaming with no pits	(1) Display Slide YXH L10-S29 Pass sample around class of each style of terminal	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Concave solder fillets in proper places.		
(3) No solder wicking on wire		
(4) No copper showing		
(5) Wire wrap and positioning correct		
(6) Wire and strand contours visible		
(7) Hole completely filled over with solder		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. The indications for multiple wire side entry connections	c. Display Slide YXH L10-30	
(1) All the indications listed for single wire joint		
(2) Additional wires alternating direction of wrap		
(3) Smooth flows of solder forming fillets between wires and between additional wires and terminal ears.		
d. The indications for completed top entry connections.	d. Display Slide YXH L10-S31	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Solder, smooth and gleaming with no pits.		
(2) Concave solder fillets in proper places.		
(3) No solder wicking on wire.		
(4) No copper showing.		
(5) Wire and strand contours visible.		
(6) Hole completely filled over the solder.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(7) Filler wire properly inserted.		
e. The indications for completed bottom entry connections are:		
(1) The same as those listed for single wire side entry connections		
(2) Wire free inside shank of terminal		
f. Insulation clearance must be checked. Clearance specifications are the same whenever insulated wire is used	f. Dispaly Slide YXH L10-S32	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Minimum - not imbedded in the solder joint		
(2) Maximum - no more than twice the diameter of the wire including the insulations		
3. Reasons for rejection:		
a. Wire damaged in any manner.		
b. Solder wicking up wire.		
c. Improper solder quantity.		

517

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Poor wetting action.		
e. Improper wire wrap or positioning.		
f. Improper soldered area.		
g. Solder defects.		
G. Safety precautions	G. Stress that it is important that the safety precautions be observed at all times.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
H. Demonstration		
1. Soldering bifurcated terminals	1. Instructor should demonstrate the proper technique and use of tools while showing the students how to solder bifurcated terminals as covered during the lesson.	1. Observe and ask questions if necessa
III. APPLICATION		
A. Performance Sheet	A. Supervise each student's completion of performance sheet. Emphasize safety.	A. Complete performance sheet. Ask question if procedures are not clear.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary		
2. Purpose of summary		
B. Directions to students		
1. Questions		
2. Notes		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Recap of lesson	C. Emphasize safety	C. Ask questions if material not clear; check notes to insure accuracy and completeness
1. Lesson is completely summarized during demonstration by instructor.		
V. INFORMAL TEST		
A. There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application".		
VI. ASSIGNMENT		
A. Read and study 3-3-1N.	A. Provide students with the homework assignment.	A. Ask questions if the assignment is unclea Complete assignment.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program
A-100-0034

Security Classification: UNCLASSIFIED

Lesson Topic 3.4:
Soldering Connector Pins

Time Allocation: Classroom - 1.75 Hours
Laboratory - 5.75 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
   a. MERP/2M Kit
2. Training Aids
   a. Slides
      (1) YXH L11-S1 through YXH-L11-S20
3. Training Aids Equipment
   a. Slide Projector
   b. Screen, Projector, Standard
4. Text
   a. Student's Guide
5. References
   a. MIL-STD-454D
   b. MIL-S-4573C
   c. NHB 5300.4 (3A)

TERMINAL OBJECTIVES

Supported partially by this lesson topic:

5.0 CONNECT wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connnector pins using the proper tools and soldering techniques following the procedures and to the standards outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4 (3A).

ENABLING OBJECTIVES

When you complete this lesson, you will be able to:

3.4.1 PREPARE connector pins for soldering by cleaning and tinning following procedures and to the standards outlined in MIL-S-45743C.

3.4.2 PREPARE wires for soldering by stripping and tinning following the procedures and to the standards outlined in MIL-S-45743C.

3.4.3 CONNECT prepared wires to connector pins using the proper tools and soldering techniques following the procedures and to the standard outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4 (3A).

CRITERION TEST

The student will be required to perform a minimum four connections to connector pins using the soldering techniques as outlined in Performance Sheet 3-4-1P and to the standards in MIL-STD-454D and MIL-S-45743C.

HOMEWORK

Complete assignment sheet 3-4-1A

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills Seek to motivate. Tell a good tie-in story if possible	
C. Effect	C. When following a subject matter lesson topic, do the following:	
	1. Explain relationship of this lesson of previous lesson(s).	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	2. Commend students for mastery of skills in previous lesson(s)	
D. Overview	D. Overview lesson by:	
	1. Stating learning objectives as contained on cover pages to this topic	
	2. Stating procedures to be followed during the lesson	
	a. Taking notes	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	b. Asking questions	
	c. Use of criterion test	
	3. Invite questions concerning objectives and procedures	3. Ask questions concerning objectives or procedures if in doubt
II. PRESENTATION		
A. Types, sizes and usage of solderable connector pins	A. Point out high points on slides while giving lecture on connector pins	A. Take notes - ask questions
1. Identifying solderable pins	1. Display Slide YXH L11-S2,	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Although most pins can be soldered, only certain pins are DESIGNED to be soldered.		
b. Identified by a curved cutout on one side of the pin.		
c. Pins which have a small hole drilled in the side at the bottom of the wire socket can be identified as designed for crimping- the small hole is for visual inspection of wire bottoming prior to crimping.		
2. Common types and sizes		
a. Connector pin size- microscopically small - to so large that you would strain to lift it.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The common sizes- those designed to accommodate wire between AWG 28 and AWG 14.		
c. Common, noncylindrical shapes of connector pins have the same shapes as terminals taught in previous lessons and will thus not be disscussed in this lesson (eyelet, turret, and pierced tab, etc.)		
d. There are other less common and much more difficult to reliability solder pins in use which are taught in a more advance course.	d. Covered in NAVAIR micro course	
e. Concentrate on solder cup style connector pins		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Use		
a. Connector pins serve as quick, easy disconnect points for disassembly of units		
b. Connector pins serve to pass signals and voltages through airtight bulkheads		
B. Preparing connector pins for soldering	B. Display Slide YXH L11-S3	
1. Tinning - always tin the pin prior to soldering		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Cleaning connector pins is difficult due to their shape; tinning is the preferred method.	a. Stress	
b. Connector styles which have remained unchanged for years are common, resulting in replacement connectors which have been stored for many years and which have the resultant oxidation on the surface.		
c. When repairing a connector for reuse (changing wires), old solder must be removed.		
d. The most reliable cleaning mehtod for removing unwanted solder is to wick it out.	c. Stress	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Prefilling		
a. Prefilling (form of tinning)- the placing of the correct amount of solder in the solder cup to form a finished solder joint. The used of preforms for consistent solder quantity is recommended.	a. Display Slide YXH L11-S4	
b. Eliminating the need for a third hand to apply solder while holding the wire in one hand and the heating device in the other.	b. Display Slide YXH L11-S5	
C. Preparing wire for soldering to connector pins	C. Display Slide YXH-S6	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Tools used - the same tools used in prior lessons		
2. Stripping - same as previously taught.		
3. Tinning - tinning techniques are the same as previously taught	3. Stress - uniform tinning of wires	
4. Bending - no wire bending is required		
5. Cutting to length		
a. Cut wire to the proper length for soldering to connector pins		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Insert wire into connect cup to measure length of wire needed for that size of pin.		
c. Ensure that the pin used as a depth guage is empty of solder.		
d. After the first wire is cut to proper length, it is used as a guage for cutting subsequent wires.		
6. Insulating tubing		
a. Insulating tubing should be used on all connector pins due to their close proximity and the danger of electrical short circuits		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Insulating tubing may be either fixed size or heat-shrinkable		
c. Heat shrinkable tubing is recommended as it provides good insulation with less bulk and is not subject to becoming useless from slipping up off the connection		
d. ALWAYS insert insulation over wire prior to soldering	d. Stress	
e. Tubing may be shrunk by using the solder extractor unit in the pressure mode for a heat source		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. Exercise extreme caution when applying heat to shrinkable tubing (too much is worse than not enough)	f. Stress	
D. Connector pin solder connection specifications	D. Display Slide YXH L11-S7	
1. Wire wrap - no wrapping to be done on connector solder cups		
2. Wire position - the wire shall be aligned exactly with the axis of the connector pin	2. Display Slide YXH L11-S8	
3. Wire depth - the wire MUST BE BOTTOMED IN THE SOLDER CUP to prevent flux or air being entrapped in the bottom of the solder cup	3. Stress: wire bottomed in cup	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Area to be soldered	4. Display Slide YXH L11-S9	
a. Solder cup should be filled with a quantity of solder that will NOT allow the wire strands to be visible after soldering, but does not bulge beyond the confines of the cup or spill down over the sides of the pin.		
b. Edges of the cutaway portion of the cup shall be visible beneath the solder with no portion of the internal face of the solder cup showing.		
c. Circular, concave fillet around the wire where it enters the solder cup.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
5. Solder quantity - shall be such that there shall be no solder spillage onto the outer walls of the pin, and the edges of the solder flow at all points shall meet the pin or wire in a concave fillet		
E. Tools used to make connector pin solder connections		
1. Hand tools	1. Same as previously used	
2. Power tools		
a. Resistance soldering tweezers	a. Stress safety precautions	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
F. Techniques for making high quality connector pin solder connections	F. Display Slide YXH L11-S10	
1. Application of flux - except the flux contained in the solder, the application of flux is undesirable except in cases of extreme oxidation since excessive flux may become trapped in the bottom of the solder cup or cause solder spilling onto outside of the pin	1. Stress no external flux needed	
2. Proper heat		
a. In soldering connector pins there are three primary methods of applying heat, all of which are reliable		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Soldering iron used to solder a pin- using the conductive heating method. Note the use of the thermal shunt to prevent wicking	(1) Display Slide YXH L11-S11. Stress thermal shunt and anti wicking tools	
(2) A resistance probe used to solder a pin- using the resistive heating method	(2) Display Slide YXH L11-S12	
(3) Resistance tweezers used to solder a pin- using the resistive heating method	(3) Display Slide YXH L11-S13	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	NOTE: Explain that there are two types of tips for resistance soldering, Carbon and Tungsten, each having its advantages: Carbon is easier to keep clean and provides greater heat, but is extremely fragile. Tungsten oxidizes and requires greater attention to keep clean, but is much more durable.	
b. Conductive heating with the soldering iron is an acceptable method but has the following disadvantages		
(1) The tip must be extremely clean and dry to prevent leaving solder tits on the outside of the pin		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) The entire heating element of the iron must be hot for it to work, which may burn surrounding wire and insulation	(2) Stress- hot element and wire damage	
c. Resistive heating with the probe (which heats by high current flow through the resistance of the pin itself) has the following disadvantages		
(1) It requires a second conductive lead which must be attached to some other part of the pin		
(2) Holding the single probe point against the rounded surface of the pin caused slippage which can result in severe arcing and burning of the pin		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Resistive heating with the resistive tweezers heats by the same method as the probe and has only the one disadvantage of arcing is misused.		
e. Resistive soldering is extremely fast and efficient as a heating source and should be controlled by the following means.		
(1) The current flow must be adjusted to the proper level for the thermal mass of the pin		
(2) Great care must be used in adjusting the current level since most resistive heating sources are capable of pin DESTRUCTION by overheating if the current level is set too high.	(2) Stress start at zero and turn up slowly for melt	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) If using a stepped current source, fine control of generated heat is accomplished by utilizing a pumping action of the footswitch to apply power intermittently		
3. Application of solder		
a. In connector pin soldering, the wire is applied to the wire solder rather than applying the solder to the wire as you have been doing.		
b. To properly apply the wire to the solder, use the following steps:		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) First step should be to place an anitwicking tool on the wire. The wire insulation should always be firmly bottomed in the larger section of the hole drilled through the tweezer tool head, and the jaws thoroughly cleaned of any flux or other foreign matter	(1) Display Slide YXH L11-S14. Stress antiwicking tool use	
(2) If using the resistance heating method, thoroughly clean the tool tip with emery cloth prior to placing on the terminal as oxide buildup may cause arcing.		
(3) Always place the tool tip on the pin prior to applying power to prevent arcing and burning of the pin.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Apply power (or the soldering iron) and observe the pin for solder melt.		
(5) Upon solder melt, immediately insert the tip of the wire partially into the solder cup at about a 70-degree angle and hesitate for a second to allow heat sinking action of the cold wire to be overcome.		
(6) After the solder remelts, VERY QUICKLY move the wire to a full vertical position and bottom it in the solder cup.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(7) Maintain a slight downward pressure on the wire until the power (soldering iron) has been removed and the solder has solidified. This downward pressure will aid in preventing the formation of stress lines in the solder.		
G. Cleaning after soldering	G. Display Slide YXH-S15.	
a. As ALWAYS, the soldered connection must be properly cleaned after completion.	a. Stress cleaning	
b. The most effective method for connector pins is the use of a bristle brush and solvent.		1019

1018

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
H. Inspecting completed connector pin solder connections for quality	H. Display Slide YXH L11-S16	
1. Standards of acceptance		
a. Correct insulation clearance		
b. Correct insulation clearance		
c. Proper solder quantity		
d. SMOOTH gleaming solder finish		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Indications to look for		
a. Preferred solder connections	a. Display Slide YXH L11-S17	
(1) Concave solder fillets		
(2) Bright, gleaming finish		
(3) Ideal amount of solder		
(4) No solder spillage		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Insulation clearance is correct		
b. No solder defects, especially stress lines, which are common in solder cup connections		
3. Reasons for rejection		
a. Unacceptable solder cup connection for the following reasons	a. Display slide YXH L11-S18	
(1) There is a large stress line at the bottom of the solder cutout	(1) Stress the stress line on slide	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) The wire is birdcages below the insulation		
(3) The wire is nicked		
b. Other defects to look for		
(1) Improper insulation clearance		
(2) Solder spilled on sides of terminal		
(3) Arc spots on sides of pin caused by improper use of the resistance soldering tools		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Safety precautions	I. Display Slide YXH L11-S19	
1. Even though the resistance tools are operated at a very low voltage, there is always a chance of shock if the hands are wet. Use common electrical safety precautions to prevent injury		
2. Same safety as previous lessons		
J. Demonstration		
1. Soldering connector pins	1. Instructor should demonstrate the proper techniques and use of tools while showing the students how to solder connector pins as presented during the lesson	1. Observe and ask questions if necessary

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPLICATION		
A. Performance Sheet 3-4-1	A. Supervise each student's completion of performance sheet 3-4-1	A. Complete performanc sheet 3-4-1. Ask questions if procedures are not clear
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student	
1. Nature of summary		
2. Purpose of summary		1061
B. Directions to students		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Questions		
2. Notes		
C. Recap of lesson	C. Emphasize safety	C. Ask questions if material not clear; check notes to insure accuracy and completeness
1. Demonstration will cover lesson recap		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
V. INFORMAL TEST		
A. There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application".		
VI. ASSIGNMENT		
A. Assignment Sheet 3-4-1A	A. Provide students with the homework assignment	A. Ask questions if the assignment is unclear. Complete assignment.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Minature/Microminiature Electronic Repair
(2M) Program A100-0034

Lesson Topic 4.1:
Introductions to Micro-Electronic Circuit Boards

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 1.0 Hours
Laboratory - 0.0 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment

    a. MERP/2M Kit

2. Training Aids

    a. Slides

        (1) YXP-L2-S1 through YXP-L2-S5

3. Training Aids Equipment

    a. Projector, slide

    b. Screen, Projection, Standard

4. Text

    a. Student's Guide

5. References

    a. MIL-STD-454D

TERMINAL OBJECTIVES

Supported entirely by this lesson topic: NONE

Supported partially by this lesson topic:

6.0 REPLACE component parts on micro-electronic printed circuit boards using the correct tools and solderin techniques and APPLY the proper conformal coating in accordance with the procedures and to the standa outlined in MIL-STD-454D.

7.0 REMOVE conformal coatings from micro-electronic printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.

8.0 REMOVE micro-electronic printed circuit board component parts using the correct tools and desoldering techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.

ENABLING OBJECTIVE

When you complete this lesson topic, you will be able to:

4.1.1 IDENTIFY the characteristics and handling of micro-electronic circuit boards. Identification will be complete agreement with the characteristics outlined in MIL-STD-454D.

CRITERION TEST

The students will be required to identify selected micro-electronic boards by their various physical characteristics and practice the proper handling of the same boards in accordance with the information outlined in MIL-STD-452D.

HOMEWORK

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills.	
	4. Seek to motivate. Tell a good tie-in story if possible.	

1072

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Effect	C. When following a subject matter lesson topic, do the following:	
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	
D. Overview	D. Overview lesson by:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Stating learning objectives as contained on cover pages to this topic.	
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes.	
	b. Asking questions.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	c. Use of criterion test.	
	3. Invite questions concerning objectives and procedures.	3. Ask questions co cerning objectiv or procedures if in doubt.
II. PRESENTATION		
A. Definition and Scope of Micro-Miniature Electronic Repair.	A. Display Slide YXP-L2-53	A. Students take notes, ask questions.
1. Definition - Micro-Electronic Repair, as it pertains to this lesson, is any electronic repair which requires a performance skill level greater than possessed by the "Average" repair technicians.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Abilities and skills to be achieved during course.		
a. Proper indentification and use of all components of the 2M Micro-Miniature Electronic repair Stations.		
b. Correct analyzation of workpiece construction and evaluation of damage to be repaired.		
c. Indentification of high quality micro-miniature sloder connection characteristics.		

260

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Proper utilization of tools and techniques to remove conformal coatings, perform desoldering, and remove components from the work piece.		
e. Proper utilization of tools and techniques to install micro-electronics components on single and double sided printed circuit boards.		
f. Correct preparation, application and curing of conformal coatings.		
B. Characteristics of micro-miniature solder connections on single and double sided boards.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Solder connection characteristics.	1. Slide of characteristics.	
a. Solder area	a. Point out on slide and pass board around.	
b. Solder quantity	b. Use slide, pass board around.	
(1) Preferred		
(2) Acceptable		
(3) Lead contour visible		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Solder finish	c. Show slide	
(1) Bright gleaming appearance		
(2) No pits or holes		
d. Wetting	d. Show slide	
(1) Solder flow to edges of pads		
(2) Solder blends into surface with no ridges.		

564

565

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. Solder defects		
(1) All connection free of solder defects covered in lesson on high reliability soldering.		
C. Characteristics and handling of microminiature circuitry	C. Display slide YXP-L2-S4	
1. Circuitry characteristics		
a. There are many characteristics of electronic circuitry used today which require that technicians performing repair possess exceptal skill		

1058

1087

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The first charateristic is the minute size of components and associated circuitry.		
(1) Size is one of the most common factors requiring special skills of the repair technician since a microscope must often be used to perform the work.		
(2) Size alone, however, is far from being the only characteristic requiring special repair skills.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Another common characteristic is conformal coatings which are extremely difficult to remove. This situation often requires skill well above average to remove the coating without causing damage to components and associated circuitry on the workpiece.		
d. Components which are highly susceptible to various types of damage are a characteristic of microelectronics. Components in this category require replacement. Solder characteristics are the same as for miniature soldering.		
e. Circuit board laminates often requite above average skills of repair technicians due to size, damage susceptibility, or complexity.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. Another circuit characteristic which requires micro-electronic level repair skills, although the circuitry and components are nct "micro-electronic" as such, is high density packaging of standard discrete components.		
g. A final characteristic and the one generally requiring the most skill to perform repair, is that of extensive workpiece damage.		
(1) When extensive workpiece damage exists, the repair is often more of a manufacturing process than a repair process. For this reason a great deasl of skill is required of the repir technician when repairing extensive damage.		

1093

1094

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) This type of repair action also requires, in most cases, a number of special materials which are not generally available to the average repair technicain.		
h. Beside the requirements for special skills, many of the characteristics of micro-electronic circuits also necessitate the use of special tools. The delicacy and expense of these tools preclude their distribution to any but a select few highly trained and skilled repair technicains.		
2. Proper handling techniques		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. To avoid wokpiece damage, constant attention and care must be given to handling procedures both before and after the repair process, as during the repair process.		
b. During the repair process particular attention must be given to the use of proper repair techniques to avoid causing damage to components or circuits.		
c. During all stages of handling remember that someone's life generally depends upon the proper functioning of the workpiece you are repairing.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPICATION - NONE		
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary		
2. Purpose of summary		
B. Directions to students		
1. Questions		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Notes		
C. Recap of lesson	C. Emphasize safety	C. Ask quesiton if materi not clear; check notes to insure accuracy anc completeness.
V. INFORMAL TEST		
A. There is not informal test for this lesson topic.		
VI. ASSIGNMENT	VI. Provide students with the homework assignment.	VI. Ask questions if the assignment is unclear. Complete assignment.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program
A-100-0034

Lesson Topic 4.2:
Microminiature Repair Task Identification and Procedural Anaysis

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 3.0 Hours
Laboratory - 0.0 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
    a. MERP/2M Kit
2. Training Aids
    a. Slides YXP L-5S1 through YXP L5-S90
3. Training Aids Equipment
    a. Projector, Slide
    b. Screen, Projection, Standard
4. Text
    a. Student's Guide
5. Reference
    a. Volume 6, PACE Rework and Repair Technology Series

TERMINAL OBJECTIVES

6.0 REPLACE component parts on micro-electronic printed circuit boards using the correct tools and soldering techniques and APPLY the proper conformal coating in accordance with the procedures and to the standards outlined in MIL-STD 454D.

7.0 REMOVE conformal coatings from micro-electronic printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.

8.0 REMOVE micro-electronic printed circuit board components parts using the correct tools and desoldering techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.

1104

573

1103

ENABLING OBJECTIVE

When you complete this lesson topic, you will be able to:

4.2.1 IDENTIFY the repair task of various types of micro-electronic ciruit boards by visual inspection and procedural analysis of selected micro-electronic circuits. Identification will be in agreement with the connections listed in Volume 6 of the PACE Rework and Repair Technology Series.

CRITERION TEST

Given selected micro-electronic circuit boards the student will be required to identify by visual inspection and procedural analyses the repair tasks to be performed during the remainder of the course. Identification will be in agreement with the connections in Volume 6 of the PACE Rework and Repair Technology Series with minimum degradation to the circuit boards.

HOMEWORK

Read and study Notetaking Sheet 4-2-1n of the Student's Guide

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating.	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills.	
	Seek to motivate. Tell a good tie-in story if possible.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Effect	C. When following a subject matter lesson topic, do the following:	
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	
D. Overview	D. Overview lesson by:	
	1. Stating learning objectives as contained on cover pages to this topic.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes.	
	b. Asking questions.	
	c. Use of criterion test.	
	3. Invite questions concerning objectives and procedures.	3. Ask questions concerning objectives on procedures if in doubt.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
II. PRESENTATION		
A. Circuit Board Construction	A. Display slides and explain C/B construction.	A. Follow lesson taking notes and ask questions if necessary.
NOTE: Only those construction details which you have not learned in previous training will be covered in this lesson.		
1. Extremely high density circuits		
a. One category of module you will be required to work on, in micro-electronics repair, is the type which uses standard circuitry and discrete components, but is constructed using extremely high density component packaging.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) The use of standard packaging. Unless other complications of construction such as thick coating or welded leads exists, this is not a micro-miniature repair task.	(1) Display slide YXP L5-S2.	
(2) Both standard and high density packaging may be a microminiature repair task if failure occurs in a high density area.	(2) Display slide YSP L5-S3.	
(3) High density packaging - with the very thick conformal coating used on some modules, combined with the density of packing, makes it a micro-minature repair task	(3) Display slide YXP L5-S4.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) The extremely high density packaging and epoxy potting used on submodules makes it necessary to use microminiature repair techniques on a submodule even though it uses only discrete components.	(4) Display slide YXP L5-S5.	
(5) Assorted high density modules	(5) Display slide YXP L5-S6	
(a) The square module uses extremely high density packaging and has many memory unit submodules. This module should be repaired with microminiature techniques		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) The three long rectangular modules use high density packaging but will not normally require microminiature repair techniques		
(c) The black micro-circuit is actually a hybrid submodule. It has an integrated circuit (IC) chip in the top and micro-miniaturized discrete components, with welded leads, potted into the bottom. The discrete components may be replaced but it is definitely a micro-miniature repair task.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(d) The "flat pack" IC circuit itself is not repairable. It should only be changed with micro-miniature techniques		
2. Hybrid circuits	2. Explain the construction of the various hybrid circuits.	
a. A hybrid circuit is one which contains both discrete components and micro-circuits		
b. Hybrid circuits are a second category which require the use of micro-miniature repair techniques		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. The following describes typical examples of hybrid circuits and their construction		
(1) A hybrid contains a combination of discrete components and IC submodules. The submodules, in turn, are also a form of hybrid circuit.	(1) Display slide YXP L5-S7.	
(2) Submodules should be removed or replaced only with micro-miniature techniques	(2) Display slide YXP L5-S8.	
(3) A ceramic printed circuit (CPC) is hybrid since it contains both thin film circuitry and discrete components.	(3) Display slide YXP L5-S9.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Hybrid CPC with all discrete components lap soldered to module.	(4) Display slide YXP L5-S10.	
	NOTE: The the components which appear to be flat pack ICs have only six leads. These are actually not ICs but two transistors in a single can.	
(5) A CPC which contains both IC chips and discrete components.	(5) Display slide YXP L5-11.	
	NOTE: The large blocks are monolithic capacitors. The circuit size is about 1¼" by 3/4" and is equivalent to a medium scale integration (MSI) IC.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) The circuit board, contains a combination of IC chips and discrete components.	(6) Display slide YXP L5-S12.	
3. CPCs	3. Explain that the following series of slides will show some typical examples of CPCs and describe their construction.	
a. The majority of CPCs are hybrid circuits using both film (thick or thin) and discrete components		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Alumina is a substrate ceramic mateial which has a very high thermal conductivity, low dielectric loss even at high frequencies, and can withstand very high temperatures. The substrates used are from 0.010" to 0.035" thick.	(1) Display slide YXP L5-S13.	
(2) Typical thin film circuits	(2) Display slide YXP L5-S14	
(a) Thin film is a term used to denote the method by which film circuitry (conductive, resistive, or dielectric ink) is applied to the substrate		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) Thin film circuitry is deposited in a vacuum-by-vacuum deposition (vaporizing material in a vacuum at 200 degrees to 400 degrees C) or cathode sputtering (using an electric potential to discharge material into a vacuum)		
(c) The conductor film thickness is 10,000 to 30,000 Angstroms (25,000 A = 0.0001") and the width is 0.005" to 0.020"		
(3) The film circuit closeup	(3) Display slide YXP L5-S15	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) The yellow areas are insulating layers		
(b) The thin dark lines are resistors		
(c) Thin film circuits are dip soldered with a thickness of 0.0005" to 0.002"		
(d) When finished, thin film circuits are coated with powdered glass (fired at low temperature) or polyurethane		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) First construction step of thick film CPC	(5) Display slide YXP L5-S17.	
(a) The first layer of conductors and insulation has been screened on a fused to the substrate		
(b) Conductors are platinum and gold paste fired in an oven at approximately 1600 degrees F		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) Second step of thick film CPC contruction	(6) Display slide YXP L5-S18	
(a) A layer of high density carbon ink screened on and fused to the circuit to form resistors		
(b) The resistive ink is fired at approximately 1200 degrees F.		
(7) Third step of thick film CPC construction	(7) Display slide YXP L5-S19.	

592

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) The resistors are trimmed away until the proper value is attained		
(b) These trimmed areas can be seen as notches in the black material		
(8) Trimming CPC components	(8) Display slide YXP L5-S20.	
(a) The machine used is a microminiature air abrasive (sandblasting) machine		

1111

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) Recently some manufacturers have also begun to use a laser for the trimming operation		
(9) Plated-through holes on CPC for double-sided use.	(9) Display slide YXP L5-S21.	
(10) Typical operational thick film CPC package which is about 3/4" square	(10) Display slide YXP L5-S22.	
(11) Operational CPC package with top removed	(11) Display slide YXP L5-S23.	
	NOTE: The leads from circuit to exterior connections and crom circuit to discrete components	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(12) Closeup of operational CPC package	(12) Display slide YXP L5-S24.	
(a) Shown are transistor chips, gold alloy circuitry, and a screened resistor. The chips are scrub-bonded to the circuitry by ultrasonic soldering		
(13) CPC submodule with aluminum cover	(13) Display slide YXP L5-S25.	
(14) CPC submodule with cover removed	(14) Display slide YXP L5-S26.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) The circuit contains four screened resistors and three scrub-bonded transistors.		
(15) More complex CPC submodule	(15) Display slide YXP 15-S27	
4. Multilayer printed circuits	4. Describe the construction of multilayer printed circuits	
a. Multilayer printed circuits are used widely in current systems to reduce the size and space taken up by interconnection wiring		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Multilayer boards are made up of a series of very thin conducting and insulating layers which are laminated together to form a single circuit board		
c. The current complexity of these boards is such that computers are generally required to layout and test their physical design		
d. The individual board layers are a double-sided circuit lamination of 0.002" copper on a 0.003" thick insulation layer		
e. These thin layers are pre-impregnated with epoxy and then laminated together with heat and very high pressure		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. There are three different methods commonly used to make interconnections between conducting layers	NOTE: Multilayer printed circuits are to be repaired only by full microminiature repair technicians, graduates of NAVAIR two week course.	
g. Multilayer board interfacial connection style	g. Display slide YXP L5-S28.	
h. 18-layer MLPCB mother board	h. Display slide YXP L5-S29.	
i. 18-layer MLPCB with connector installed.	i. Display slide YXP L5-S30.	
j. Back-lighted view of 18-layer MLPCB	j. Display slide YXP L5-S31.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
k. Dissected MLPCB	k. Display slide YXP L5-S32.	
l. Internal view of post construction MLPCB	l. Display slide YXP L5-S33.	
5. Flexible printed circuits		
a. Flexible printed circuits are a fairly recent development in circuit technology		
b. Flexible circuits are highly reliable and seldom need repair. When repair is needed, the complexity and materials required demand the microminiature repair techniques be used.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Flexible printed circuits are constructed of a copper-conducting layer laminated between two layers of polymide plastic film. Multilayer flexible circuits are also made using the same techniques		
d. Assorted flexible printed circuits	d. Display slide YXP L5-550.	
	NOTE: Flexible printed circuits are to be repaired only by full microminiature repair technicians, graduates of NAVAIR two week course. Distribut various flexible printed circuits for student's inspection.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Conformal Coating Compounds		
1. Coatings on micro-circuits		
a. The conformal coatings you will deal with in micro-miniature repair are the same types that you learned to identify in previous training		
b. The application and removal of these coatings when repairing micro-circuits become much more cirtical and demand vastly increased skill level on the part of the repair technician		
c. Many times a coating may be technically defined as thin if measured, but it must be treated as a thick coat due to the relationship between coating thickness and component size		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. A thin coating on a micro-circuit which is extremely difficult to remove from around the circuit leads, must also be removed nearly 100% to enable soldering tools to properly contact the solder pad area	d. Display slide YXP L5-S57.	
e. Any conformal coating which must be removed from micro-circuit should have removal performed using only micro-minature repair techniques due to the danager of damaging the components or workpiece		
2. Extremely thick coatings		
a. Extremely thick coatings are not often encountered on circuitry using micro-miniature components unless they are completely potted or encapsulated with coating		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. You will, however, occasionally encounter micro-electronic modules with extremely thick coatings such as polyurethane coated modules.	b. Display slide YXP L5-S58.	
3. Opaque coatings		
a. Opaque coatings are very common in micro-electronics circuitry		
b. Opaque coatings are generally used to completely pot or encapsulate either individual components or submodules		
c. The majority of conformal coatings are not opaque; thus, most opaque coatings are deliberately made opaque by manufacturers for one of the following reasons		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Opaque coatings are used on highly classified circuitry as a security measure		
(2) Opaque coatings are also used by manufacturers to maintain security of unique design and manufacturing processes		
(3) One of the most common uses for opaque coatings is their application by manufacturers to serve as a detriment to repair. This is done so that the circuits will be replaced rather than repaired.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Special coating additives		
a. In addition to additives which make coatings opaque, there are additives used which increase the adhesion strength of the coating and make penetration more difficult		
b. One typical additive is aluminum oxide particles. These particles are mixed with the coating while it is in a liquid state. When the mixture is cured, it forms a compound so hard and abrasive that it will rpaidly dull even diamond-tip instruments.		
(1) This compound is most commonly used by manufacturers to protect trade secrets or to prevent repair.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Another common additive is powered silica (sand). This additive forms a coating compound even harder than aluminum oxide. Diamond-tip cutting instruments are completely useless.		
(1) Module with silica and black colorant added to the potting compound	(1) Display slide YXP L5-559.	
(2) This type of additive is most commonly used for security purposes on highly classified equipment		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Microminiature Component Characteristics		
1. Heat sensitivity		
a. Nearly all micro-electronic components are highly susceptible to damage by heat		
b. Typical micro-electronic components	b. Display slide YXP L5-S60.	
c. Inside of IC package	c. Display slide YXP L5-S61	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. If the internal parts of a micro-electronic component are allowed to reach soldering temperatures for even a short period of time, damage will result		
(1) Pictorial drawing of IC chip	(1) Display slide YXP L5-S62.	
(2) Micro-photo of an IC chip	(2) Display slide YXP L5-S63.	
2. Electrical sensitivity		
a. Except for a very few high power or high voltage devices, all micro-electronic components may be damaged by extremely small electrical potentials		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. In addition to powered circuits the potentials may be developed from such things are stray voltages on power soldering tools or static electricity from your fingers.		
c. To avoid damage, constant care must be taken to ensure that no stray voltage potential of any sort is allowed to contact components leads		
d. Particular care must be taken with normal circuit operating potentials since they will almost invariably cause damage if applied to the wrong leads		

1173

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Mechanical sensitivity		
a. All micro-electronic components are sensitive to, and easily damaged by, mechanical stresses		
b. The delicate crystalline structure of the IC chip and the glass hermetic seal around leads are both easily damaged by stresses such as dropping the component or cutting the leads with dull cutters		
c. Excessive force of stress, applied when positioning the component or bending leads, is one of the most common causes of damage		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Physical size		
a. There are literally thousands of different size-shape combinations used in making microminiature components		
b. During your previous training you have been shown the most common shapes of these components		
c. Their size varies to such great extent that it is not practical to attempt to show all the variations. Size may range from an inch or more to such microscopic dimensions that it is nearly impossible to distinguish the component with the naked eye		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. UNIVAC Module with through-board mounting	d. Display slide YXP L5-S67.	
e. Component side of UNIVAC module	e. Display slide YXP L5-S68.	
f. Close view of UNIVAC module components	f. Display slide YXP L5-S69.	
g. Close view of UNIVAC module circuitry	g. Display slide YXP L5-S70.	
h. Expanded view of pad areas.	h. Display slide YXP L5-S71.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Solder-Joint Construction		
1. Through-board joints	1. Describe some of the styles of connections the student's wouldn't be familiar with. Point out the damage on each board.	
a. Miniaturized through-board circuitry	a. Display slide YXP L5-S64.	
b. Miniaturized circuitry with design defect	b. Display slide YXP L5-S65.	
c. Through-board mounting on MLPCB	c. Display slide YXP L5-S66.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Surface joints		
a. Surface type solder joints are commonly called lap joints		
b. In this type of joint the component lead is placed or lapped on top of the solder pad area and soldered into place		
c. All connection and bonding in the surface or lap joint is formed by the solder itself. For this reason the quality and strength of the solder connection in this type of joint is exceptionally critical		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Surface joints are a very common mounting style for ICs and other micro-electronic components		
e. Module with lap-soldered ICs	e. Display slide YXP L5-S72.	
f. Rear view of module with lap-soldered ICs	f. Display slide YXP L5-S73.	
g. Closeup of lap-soldered ICs	g. Display slide YXP L5-S74.	
h. Module with lap-soldered ICs	h. Display slides YXP L5-S75 and YXP L5-S76.	
i. CPC with lap-soldered component	i. Display slide YXP L5-S77.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Solder cups		
a. PCB solder cups in use - hollow standoff similar to a connector pin	c. Display slide YXP L5-S78.	
b. The purpose of the solder cup is to act as a connection point for several component leads when vertical component mounting is used		
c. Solder cups are not microminiature, but they are normally found on a module whose packaging density requires microminiature tools or techniques for repair		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Welded leads	4. Project and briefly point out the various characteristics of slides YXP L5-S79 through YXP L5-S84.	
a. Welded leads are a fairly common occurrence as a mounting style for micro-electronic components.		
b. Welds will be either parallel gap or points contact style		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) The most common weld currently in use is the parallel gap style. It is generally used when only one of the conductors to be joined is free to move. This style is readily identifiable as it leaves a thin black line across the welded lead. A parallel gap weld is formed by bringing two parallel tips into contact with one of the leads to be joined and passing a high current pulse between the tips		
(2) Point contact welding is an older style and is generally used where both conductors to be joined are free to move. The point contact weld is formed by bringing two tips together so that the conductors to be joined are pressed between them and passing a high current pulse between the tips. Only very careful inspection will show that this type of joint is welded rather than soldered		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
E. Evaluating Repair Tasks and Procedural Steps	E. Display slide YXP L5-S90.	
1. Workpiece analysis		
a. You have been taught in previous training that before taking any action towards the repair of a workpiece, both the workpiece and the job to be done must be throughly analyzed and a complete plan of action decided upon		
b. At this point in the course, you have been taught the information needed to enable you to make a complete analysis of micro-electronic workpiece		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. When making an analysis of each workpiece, you are performing the most important part of insuring that no additional damage or degradation is incurred on the workpiece as a result of your repair actions		
2. Damage evaluation		
a. The next step of your preparation for repair is to locate all damage or failures on the workpiece, and determine their extent		
b. The nature of all damage and the area affected must be determined before you can effectively outline the repairs to be performed		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Task determination		
a. When the workpiece has been completely analyzed and all damage evaluated, you will have the information needed to decide what repairs must actually be performed on the workpiece		
b. In determining the repair task (or tasks) remember that all steps taken in disassembly, repair, and reassembly are a part of the overall repair task		
4. Procedural outline - the final step in preparation for repair is to combine the information gained from analyzing the workpiece, the damage, and the repair task into a single comprehensive step-by-step repair procedure		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPLICATION - NONE		
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary.		
2. Purpose of summary.		
B. Directions to Students		
1. Questions		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Notes		
C. Recap of Lesson	C. Emphasize Safety	C. Ask questions if material not clear; check notes to insure accuracy and completeness.
1. Circuit board construction		
2. Conformal coating compounds		
3. Microminiature components characteristics		
4. Solder-joint construction		

1201

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
5. Evaluating repair talks and procedural steps		
V. INFORMAL TEST		
There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application."		
VI. ASSIGNMENT		
Read and study 4-2-1N	Provide students with the homework assignment.	Ask questions if the assignment is unclear. Complete assignment.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M)
Program A-100-0034

Lesson Topic 4.3:
Micro-Electronic Circuit Conformal Coating Removal and Desoldering Techniques

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 2.0 Hours
Laboratory - 8.75 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
    a. MERP/2M Kit
2. Training Aids
    a. Slides
        (1) YXP L9-S1 through YXP L6-S54
3. Training Aids Equipment
    a. Projector, Slide
    b. Screen, Projection, Standard
4. Text
    a. Student's Guide
5. References
    a. PACE Rework and Repair Technology Series, Volume 6
    b. MIL-STD-454

TERMINAL OBJECTIVES:

Supported Partially by this lesson topic:

7.0 REMOVE conformal coatings from micro-electronic printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.

8.0 REMOVE micro-electronic printed circuit board component parts using the correct tools and desoldering techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.

ENABLING OBJECTIVES:

When you complete this lesson topic, you will be able to:

4.4.1 EVALUATE the repair task to be performed and DETERMINE the proper conformal coating removal method to be used on micro-electronic printed circuit boards. Evaluation and determination will be based on information contained in Volume 6 of the PACE Series.

4.3.2 REMOVE various conformal coatings from micro-electronic printed circuit boards using the chemical, heat and abrasive methods and the proper tools as outlined in Volume 6 of the PACE Rework and Repair Technology Series.

4.3.3 DETERMINE the proper desoldering and component removal method to be used on selected micro-electronic circuits utilizing information contained in Volume 6 of the PACE Series.

4.3.4 DESOLDER various types of micro-electronic printed circuit solder connections using the wicking and motorized vacuum extraction methods of desoldering and the proper tools as outlined in Volume 6 of the PACE Series.

CRITERION TEST

Satisfactory completion of the Enabling Objectives require the student to remove the conformal coating and desolder predetermined micro components on a minimum of three selected double and/or single sided micro-electronic printed circuit boards. Procedures utilized will be in agreement with the information outlined in the PACE Rework and Repair Series, with minimum degradation to the printed circuit boards.

HOMEWORK

Read and study Notetaking Sheet 4-3-1N.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs.	
	1. Muster	
	2. Comfort	
	3. Visibility and seating	
B. Explain	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship.	
	2. The necessity of the skills and techniques in repair of printed circuit boards.	
	3. Personal applications of the knowledge and skills.	
	4. Seek to motivate. Tell a good tie-in story if possible.	
C. Effect	C. When following a subject matter lesson topic, do the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Explain relationship of this lesson to previous lesson(s).	
	2. Commend students for mastery of skills in previous lesson(s).	
D. Overview	D. Overview lesson by:	
	1. Stating learning objectives as contained on cover page to this topic.	
	2. Stating procedures to be followed during the lesson.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	a. Taking notes.	
	b. Asking questions.	
	c. Use of criterion test.	
	3. Invite questions concerning objectives and procedures.	3. Ask questions concerning objectives or procedures if in doubt.
II. PRESENTATION		
A. Conformal coating removal techniques	A. Display YYP L6-S1	A. Ask questions and take notes when necessary.

1213

1214

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Heat removal		
a. Careful application of controlled heat can be used to remove many conformal coatings, this is also true in microelectronic repair.		
b. A typical micro-electronic module with an epoxy coating on both sides.	b. Display Slide YXP L6-S2.	
(1) Heat removal methods and tools used on standard modules is not practical for removing coating from micro-electronic modules, due to the size and spacing of components.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Apply controlled heat using improved tools and techniques applicable to micro-electronic circuitry.		
2. Abrasion removal - Mechanical abrasion is another useful method of removing coatings. Suitable for micro-electronic circuits on single and double sided boards.		
3. Chemical removal		
a. The use of solvents to remove coatings is very limited since most solvents, which are strong enough to dissolve coatings, also tend to attack some components.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Always use only the solvents and procedures for coating removal which are recommended in the manufacturer specifications.	b. STRESS this fact and any safety precautions necessary.	
B. Use and capabilities of coating removal tools.	B. Display Slide YXP L6-S3.	
1. Hot air jet.		
a. The hot air jet technique is one of the most versatile coating removal methods.	a. Display Slide YXP L6-S4.	
b. The hot air jet technique uses the solder extractor in conjunction with low air pressure.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. The equipment is set up for this technique as follows:		
(1) Adjust the voltage control for the extractor plug to obtain the desired temperature.		
(2) Connect the extractor air line to the pressure output and turn the pressure control to MINIMUM.		
(3) DEPRESS the footswitch. This will cause air to flow from the extractor tip at the temperature of the heating element.	(3) STRESS: CAUTION - At maximum voltage the air temperature is approximately 1000 degrees F. and can cause great damage to the workpiece if improperly used.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. To remove coating with the hot air jet, proceed as follows:		
(1) Blow hot air to the removal area with the extractor tip approximately 1/2 inch away from the surface.	(1) Display Slede YXP L6-S5.	
(2) Use extreme care not to cause workpiece damage.	(2) Stress this point.	
(3) Using an orangewood stick or similar tool, push the coating away as it softens and overcures from the hot air.	(3) Display Slide YXP L6-S6.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. Using the hot air jet and a fine pointed tool, coating can be removed from even the most minute areas.		
2. Thermal parting		
a. Another very versatile heat removal tool is the thermal parting unit.	a. Display Slide YXP L6-S7.	
b. Prepare the equipment for thermal parting, as follows:		
(1) Connect the thermal parting tool to the low volage AC output on the HS-20.	(1) Display Slide YXP L6-S8.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Depress the footswitch.		
(3) Adjust the output control until the parting tip is at a temperature just below the melting point of solder.		
(4) The temperature may now be adjusted slightly up or down to obtain best results with with the particular coating being removed.	(4) STRESS: NOTE: ALWAYS begin the adjustment procedure with the output control set at ZERO to avoid damaging the parting tool.	
c. Remove coatings with the thermal parting tool, as follows:		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Remove coating from around the component body by overcuring and pushing the coating aside with the hot parting tip. The tip is not hot enough to cause scorching or discoloration.	(1) Display Slide YXP L6-S9.	
(2) Carefully remove coating around leads, being very careful not to touch the board surface. The coating need only be removed down to the widest point of the component body.	(2) Display Slide YXP L6-S10.	
(3) If removing a failed component, the leads may be cut, when removing a KNOWN defective part, since it is the method which normally provided the lowest risk of workpiece damage.	(3) Display Slide YXP L6-S11. Stress destructive removal for failed component.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) When the component leads have been cut, the component body should be heated, causing the remaining coating to soften and permit easy component removal.	(4) Display Slide YXP L6-S12.	
(a) One method of heating the component body is to use the thermal parting tool.		
(b) A temperature controlled soldering iron or the hot air jet is also a reliable method of heating the component body.		

1231

1232

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Once the component body has been throughly heated to weaken the coating bond, it may be removed by gripping it with a pair of pliers and applying a gentle twisting or rocking force. NEVER use a pulling or lifting force as it could result in board or conductor damage.	(5) Display Slide YXP L6-S13, "Removing Heated Component: STRESS - No lifting or pulling force should be used.	
(6) When the defective component has been removed, the surface area of the board should be smoothed and cleaned to accept the replacement part. The smoothing may be done with the thermal parting tool or by using abrasive grinding methods.	(6) Display Slide YXP L6-S14.	
(7) If non-destructive component removal is necessary, the same basic procedure is followed using two additional steps.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(a) When removing coating from the component leads, remove the coating down to the pad area exposing the solder connection.		
(b) Completely desolder the component leads prior to heating the component body for removal.		
3. Miniature machining or Dremol Kit.		
a. The miniature machining system, provided with the repair unit, is another reliable method of removing conformal coatings.		

640

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. A wide variety of bits are available with the miniature machining system. These bits allow the removal of various coatings from many different surfaces.		
(1) Module has an epoxy coating which must be removed from solder connections prior to desoldering.	(1) Display Slide YXP L6-S15.	
(2) Expanded view shows the very small size of some circuit conductors and pads.	(2) Display Slide YXP L6-S16.	
(a) Due to the small conductor size and relatively high temperature needed to remove epoxy with heat, there would be a fairly high risk of causing workpiece damage if heat removal methods were used.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) When removing hard coatings from small conductors or from large flat surfaces such as the rear of a moudle, the use of the miniature machine with an abrasive grinding bit is much less likely to cause damage than heat removal methods.		
(3) A coarse abrasive bit used to remove a hard coating from a large flat surface on the rear of a module.	(3) Display Slide YXP L6-S17.	
(4) A fine abrasive bit is being used to remove a thin conformal coating from a single solder joint.	(4) Display Slide YXP L6-S18.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Properly performed coating removal task.	(5) Display Slide YXP L6-S19. STRESS: The color difference between coated and uncoated areas.	
(6) Module with conformal coating on closely spaced components. Removal of coating from the small areas around IC leads and between components can be an easy task if the right abrasive bit is used.	(6) Display Slide YXP L6-S20.	
(7) The bristle brush bit, is generally the most reliable method of removing coating from confined areas since it is small and will form itself into the shape of the area it is in contact with.	(7) Display Slide YXP L6-S21.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(8) The bristle brush is an excellent tool for removing thin coatings completely down to the board surface without causing damage.	(8) Display Slide YXP L6-S22. Stress brush can cause serious damage if misused.	
(9) Ball mill used to remove coating.	(9) Display Slide YXP L6-S23.	
(a) The ball mill is normally used in coating removal, only to take off the majority of a thick coating.		
(b) Small ball mills may also be used to remove coating from confined areas aroung component bodies.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(c) When removing coating with a ball mill, use EXTREME CAUTION and NEVER attempt to remove a coating completely.		
(10) A module that has component leads which must be cut for removal. Note that the leads to be cut are inaccessible to cutting pliers.	(10) Display Slide YXP L6-S24.	
(11) The slotting saw bit may be used to cut inaccessible component leads. EXTREME CAUTION must be used when applying this technique as there is a great danger of causing workpiece damage.	(11) Display Slide YXP L6-S25. Stress damage CAUTION	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(12) Handling and installing of bits in the miniature machine or Dremel is the same for all of the bits supplied with the repair kit.		
C. Desoldering micro-miniature solder connections.		
1. Component Removal	1. The majority of all damage caused during the repair cycle of a module has always happened in the disassembly (component removal) phase of the work and the largest percentage of this damage has occurred during a single operation, DESOLDERING OF COMPONENTS Explain the urgent necessity for proper micro-electronic repair equipment and training. Modules on the following slides are actual tasks perfomed by IMA technicians in the field on typical micro-electronic modules.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. A module with a thin, soft polyurethane coating and lap-soldered IC leads. Note the IC removed from the upper right-hand corner.	a. Display Slide YXP L6-S30.	
b. An attempt was made to use destructive component removal and then to cold peel the remaining lap-soldered lead ends. It is obvious that the destructive portion of the plan was highly successful.	b. Display Slide YXP L6-S31.	
c. Module worked on by a different technician. Note the IC removed at third position from left in bottom row.	c. Display Slide YXP L6-S32.	
d. After destructive component removal, an attempt was made to heat and push (shovel) the cut leads off of the pads. Overheat and overpressure caused the missing pads. Note that no attempt was made to remove the coating from the leads.	d. Display Slide YXP L6-S33.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. An F-11 Memory Matrix composed of two closely space PC boards which were interconnected with straight buss wires.	e. Display Slide YXP L6-S34.	
f. The interconnecting wires were removed by the heat and pull method.	f. Display Slide YXP L6-S35.	
g. IC removed at lower left-hand corner.	g. Display Slide YXP L6-S36.	
h. Closeup of IC area. The coating was removed, destructive IC removed, lead ends clipped and cleaned with bristle brush. The original lead ends were left in place with the intention of double lap soldering the new IC in place. A much better attempt than those performed without the repair kit but still not adequate.	H. Display Slide YXP L6-S37. STRESS: Still not adequate.	

648

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
i. A multilayer board obvious damage from overheat caused by poor desoldering techniques.	i. Display Slide YXP L6-S38.	
j. Another multilayer board with damage caused by poor desoldering techniques.	j. Display Slide YXP L6-S39.	
2. Vacuum desoldering		
a. The most versatile and reliable is the continuous vacuum method.	a. Explain that much desoldering which is very difficult to perform reliably with other methods is a routine matter using continuous vacuum extraction tools.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Typical example is the multipin sub-module which must have all pins completely desoldered for removal.	b. Display Slide YXP L6-S40.	
c. Overheating damage is typical of that caused by other desoldering methods, such as the block style desoldering tip for multipin units.	c. Display Slide YXP L6-S41.	
d. A thin PC board, (approximately 0.008 inch), is very susceptible to heat damage. To make matters worse, boards of this type are often mounted on an insulated metallic substrate, which has a great heat sinking effect, making it necessary to use high heat for desoldering. This condition makes the non-continuous vacuum tools highly undesireable as they often require several reheating operations to completely remove solder from a connection.	d. Display Slide YXP L6-S42.	

650

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. A super flat pack received from the manufacturer with excessive solder, causing shorts.	e. Display Slide YXP L6-S43.	
f. Internal view of the same flat pack shows that excessive solder is also causing shorts on the inside of the unit. The solder extractor is ideally suited for removing a large quantity of solder such as this due to its continuous vacuum capabilities.	f. Display Slide YXP L6-S44.	
3. Pressure desoldering		
a. Another highly valuable desoldering capability of the extractor unit is the continuous pressure (hot air jet) mode.		

1258

1257

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Hot air at approximately 1000 Degrees F is availble when using the extractor in this mode.		
(2) The hot air jet mode can be used to blow solder out of dead end holes when vacuum will not do the job. This mode also gives a unique new desoldering capability, particularly useful in micro-electronics.		
b. A thin film PCB with lap-soldering components. Note high density packaging which makes many leads relatively inaccessible for desoldering. The hot air jet allows you to melt solder and remove lap-soldering leads from a distance if they are inaccessible. It also allows the lead to be desoldered without touching the hot tip to the joint when the pad or board laminate are extrememly sensitive to heat and pressure.	b. Display Slide YXP L6-45.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Removal of welded leads	4. Display Slide YXP L6-S46. Explain that it is often necessay in microelectronics to repair modules with welded component connections, even though we do not have welding or dewelding capabilities Using the tools and techniques taught in this course, you will be able to remove welded components and install replacement components by soldering.	
a. Cutting the lead	a. The first step in the removal of welded components is to cut the component lead.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) The welded lead is cut between the weld joint and the component (normally using cutting pliers) being very careful not to damage the pad or welded piece of lead which remains on the PCB.		
(2) The lead must be cut at the edge of the pad area.		
b. Dressing lead		
(1) When the welded component has been cut free and removed, the remaining welded lead ends must be properly dressed and prepared so that a replacement component may be soldered (rather than welded) in place.		

654

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) The welded lead tip is next smoothed down flat so that it may serve as a pad area for lap soldering the replacement component ot the PCB.		
(3) Since most welded leads are gold-plated non-solderable metal, care must be taken not to damage or remove the solderable gold plating from the lead.		
(4) If the lead is unplated, there are two methods of preparation which will allow soldering of a replacement component.		
(a) The unplated lead may be electroplated with gold so that it becomes solderable.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) The welded lead may be removed completely by abrasive methods and the replacement component soldered to the board circuitry. This method is the least desireable for two reasons:		
1. While completely removing the lead, there is a very high risk of damaging the board circuitry.		
2. The solder joint on the board circuitry must be allowed to have a gap on it or the area must be plated since the spot where the weld connection was formed will be non-solderable.		

959

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Use and capabilities of desoldering tools.		
1. Solder extractor		
a. Reliable Extraction Procedures	a. Briefly review extractor use.	
(1) Always use a stirring motion of the lead if possible, so that no sweat joints remain after desoldering (this is particularly important with multilead components)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Except for very rare instances where you have no alternative, <ins>NEVER</ins> allow the extractor tip to contact the board laminate or conductors.		
(3) The desoldering of lead terminations, which are not straight through, can be greatly simplified by using micro-miniature tools and techniques.	(3) Display Slide YXP L6-347.	
(a) The normal process is to extract all solder possible and then mechanically shear the remaining sweat joint with pliers. The shearing operation presents some risk of workpiece damage.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) The thermal parting tool may be used in place of the shearing operation. This will greatly reduce the risk of causing damage.		
(c) After extracting all the solder possible, adjust the parting tool to solder melting temperature and use it to lift (NEVER PRY) the lead to a straight through position.	(c) Stress "Never Pry".	
(d) When the leads have been lifted, the extractor may be used with the stirring action to completely desolder the lead.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) New techniques of solder extraction which apply to micro-miniature repair are those of extensive extractor tip modification to allow desoldering of a wide variety of small sized and odd shaped connections.		
(a) Since extractor tips will not fit the miniature machine chuck, they may be wedged over a ball mill which will allow them to be rotated for modification.	(a) Display Slide YXP L6-548.	
(b) A comparison between a modified and an unmodified tip.	(b) Display Slide YXP L6-550.	
(c) The inside of the tip may also be ground out to fit special shapes or sizes of leads.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(d) You can and should modify your extractor tips to any shape needed when it will result in more efficient solder extraction.	(d) Display Slide YXP L6-551.	
2. Hot air jet	2. The hot air jet technique is extremely useful for removing lap-soldered component leads.	
a. Technique for removing lap-soldered leads with the hot air jet is as follows:		
(1) Connect the solder extractor to the pressure supply and set the pressure flow control to MINIMUM.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Adjust the temperature to MAXIMUM and vary the amount of heat applied to the solder joint by varying the distance between the extractor tip and the joint.		
(3) Gently grip the lead with tweezers and blow hot air on the connection.		
(4) When a solder melt is observed, lift the lead carefully and remove the hot air flow.		
(5) When correct flow, temperature and distance are used, the solder melt should occur in approximately 2 seconds.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	NOTE: NEVER apply any lifting pressure to any lead when using this method prior to observing a COMPLETE solder melt.	
(6) Typical hot air jet desoldering operation.	(6) Display Slide YXP L6-552. Remember to alternate the operation from one side of component to another, so that there is no excessive heat buildup in a single area.	
3. Miniature machine or Moto Tool		
a. The miniature machine is classed as a desoldering tool when used in the removal of welded leads.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. It may be used to cut the leads when they are not accessible with pliers but great care must be taken not to cause workpiece damage.		
c. The miniature machine is also used to clean and smooth sharp edges on the remaining lead after the component has been cut away.		
d. It may also be used to grind away the welded lead end when necessary, must be used with great caution to avoid causing damage. NEVER attempt to separate a welded joint with heat or pressure as circuit conductor damage will almost invariably result.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
E. Evaluating disassembly for completeness and quality.	E. Display Slide YXP L6-S53.	
1. Coating removal -	1. State that all steps of the disassembly process must be thoroughly evaluated for completeness and quality before making ANY repair or replacement action.	
a. Completeness - check that all coating removal necessary for the entire repair cycle of the workpiece has been performed and that no part of the remaining coating will interfere with future repair, component mounting, or soldering.		

1286

1285

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Quality - check that no workpiece damage has been caused and that all remaining coating is free of charring, cracking, or debonding.		
2. Desoldering	2. The next step is to check all desoldering operations for completeness and quality.	
a. Completeness - check that all desoldering necessary to the entire repair has been performed and that all desoldered holes and pads are free of excess solder.		
b. Quality - check that no board or conductor damage has been caused;		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Welded lead preparation	3. The next step is to check the preparation of all welded leads (if any) for completeness and quality.	
a. Completeness - check that all leads have been cut, cleaned and smoothed so that they are suitable as a solder pad for replacement components.		
b. Quality - Check that no workpiece damage has been caused during lead preparation and that soldering plating is complete and undamaged to permit reliable soldering.		
4. Workpiece damage	4. Careful evaluation must how be performed on any workpiece damage found in the previous steps.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Determine if any hidden damage was discovered as a result of disassembly and if so, incorporate its repair into the overall repair task analysis.		
b. Determine if any workpiece damage was caused by disassembly and if so, take the following steps.		
(1) Evaluate the cause of the damage and take immediate action to insure that similar damage is not caused on future workpieces.		
(2) Incorporate repair of the damage into the overall repair task analysis.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
F. Safety precautions	F. Display Slide YXP L6-S54, and review the safety precautions previously presented.	
H. Demonstration		
1. Micro coating removal and desoldering demonstration	1. Instructor should demonstrate the proper techniques and use of tools while showing students how to remove coating and desolder micro-electronic circuit boards covered during lesson.	1. Observe and ask questions as necessary.
III. APPLICATION		
A. Performance Sheet 4-3-1P	A. Supervise each students completion of Performance Sheet 4-3-1P, emphasizing safety.	A. Complete Performance Sheet 4-3-1P. Ask question if procedures not clear.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary.		
2. Purpose of summary		
B. Directions to student		
1. Questions		
2. Notes		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Recap of lesson is conducted during demonstration by instructor.	C. Emphasize safety.	C. Ask questions if material not clear, check notes to insure accuracy and completeness.
V. INFORMAL TEST		
A. There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application".		
VI. ASSIGNMENT		
A. Notetaking Sheet 4-3-1N	A. Provide students with the homework assignment.	A. Ask questions if the assignment is unclear. Complete assignment by reading and studying 4-1-1N.

FLEET TRAINING CENTER
NAVAL STATION
NORFOLK, VIRGINIA 23511

Miniature/Microminiature Electronic Repair (2M) Program
A-100-0034

Lesson Topic 4.4:
Micro-Electronic Circuit Soldering Techniques

Security Classification: UNCLASSIFIED

Time Allocation: Classroom - 2.0 Hours
Laboratory - 8.75 Hours

INSTRUCTIONAL MATERIALS

1. Training Equipment
   - a. MERP/2M Kit
2. Training Aids
   - a. Slides
     - (1) YXP L9-S1 through YXP L9-S31
3. Training Aids Equipment
   - a. Projector, Slide
   - b. Screen, Projection, Standard
4. Text
   - a. Student's Guide
5. References
   - a. MIL-STD-454D
   - b. MIL-C-47256 (M.I.)

TERMINAL OBJECTIVE

Supported Partially by this lesson topic:

6.0 REPLACE component parts on micro-electronic printed circuit boards using the correct tools and soldering techniques and APPLY the proper conformal coating in accordance with the procedures and to the standards outlined in MIL-STD-454D.

ENABLING OBJECTIVES

When you complete this lesson topic, you will be able to:

4.4.1 POSITION components on micro-electronic printed circuit boards using the preferred mounting procedures outlined in MIL-STD-454D.

4.4.2 SHAPE component leads for mounting on micro-electronic printed circuit boards without damaging the leads or components and meeting all bend specifications as listed in MIL-STD-454D.

4.4.3 REPLACE electronic components on micro-electronic printed circuit boards utilizing the proper tools and soldering techniques for high quality solder connections following the procedures and to the standards as outlined in MIL-STD-454D.

4.4.4 INSPECT micro-electronic printed circuit solder connections on selected boards and DETERMINE that their quality and reliability are in accordance with the standards outlined in MIL-STD-454D.

4.4.5 IDENTIFY the proper conformal coating that should be applied to various micro-electronic printed circuit boards. Identification will be in complete agreement with the information contained in MIL-C-47256(M.I.).

CRITERION TEST

The student will be required to replace a minimum of at least two each of Dual-in-line, Flat-pack and TO-5 integrated circuits (IC's) on selected micro-electronic single and/or double sided printed circuit boards. The procedures and techniques utilized will be in accordance with those outlined in MIL-STD-454D and to the specifications listed therein.

HOMEWORK

Read and study Notetaking Sheet 4-4-1N.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. INTRODUCTION		
A. Contact	A. Introduce self and topic. Provide for students needs:	
	1. Muster	
	2. Comfort	
	3. Visibility and seating.	
B. Readiness	B. Explain value of subject matter, pointing out where appropriate, its relationship to the following:	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	1. Accomplishment of daily tasks aboard ship. 2. The necessity of the skills and techniques in repair of printed circuit boards. 3. Personal applications of the knowledge and skills. Seek to motivate. Tell a good tie-in story if possible.	1305

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Effect	C. When following a subject matter lesson topic, do the following: 1. Explain relationship of this lesson to previous lesson(s). 2. Commend students for mastery of skills in previous lesson(s).	
D. Overview	D. Overview lesson by: 1. Stating learning objectives as contained on cover pages to this topic.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	2. Stating procedures to be followed during the lesson.	
	a. Taking notes.	
	b. Asking questions.	
	c. Use of criterion test.	
	3. Invite questions concerning objectives and procedures.	3. Ask questions concerning objectives on procedures if in doubt.

1309

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
II. PRESENTATION		
A. Components Preparation	A. Display YXP L9-S1.	A. Take notes, ask questions and observe slides and drawings.
1. Performed leads		
a. Many microminiature components today come from the manufacturer with performed leads		
b. Preformed leads will greatly ease your job in component preparation but they also require special handling to avoid damaging the lead configuration		
2. Specifications and standards		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. The specifications and standards for round lead components shall be the same as those learned in previous training		
b. The only additions to the specifications apply to flat leads and lap joints. The additions are as follows:		
(1) Leads shall contain two distinct bends at an approximate angle of 45 degrees	(1) Display slide YXP L9-S2	
(2) The lead shall be in contact with the solder pad from the second bend to the lead tip	(2) Display slide YXP L9-S3	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) The contact area of the lead shall not overhand the edge of the solder pad at any point	(3) Display slide YXP L9-S4.	
(4) The contact area of the lead must be a minimum of ½ the length of the solder pad	(4) Display slide YXP L9-S5.	
3. Recommended forming tools		
a. There are a large variety of forming tools for multilead components (IC) which are satisfactory for use. Their cost is generally high, however, since a different forming tool must be used for each lead configuration		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. For this reason hand-forming tools are recommended in most cases		
c. All those tools and techniques learned in previous training are recommended for use with microminiature components		
d. For bending leads of multilead components, the following tools are recommended		
(1) Smooth jaw needle nose pliers		
(2) Smooth jaw tweezers		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Hand-forming techniques		
a. All these forming techniques learned in previous training are suitable except for the forming of ribbon leads on the "flat pack" style of multilead components		
b. For bending multilead components use the following techniques		
(1) Grip the leads with pliers or tweezers with the jaw edge which is nearest the component placed at the point of the first bend		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Smoothly push the component over to a 45-degree angle with your finger		
(3) Grip the leads in the same manner at the point of the second bend		
(4) Smoothly push the component in the opposite direction to form the second 45-degree bend		
(5) Repeat this action on the opposite side of the component		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Component Installation		
1. Positioning considerations	1. Display slide YXP L9-S11.	
a. Whenever possible, the component should be placed symmetrically between the mounting points and have identifying marks visible		
b. The prime rule in repair, however, is to always use the same style and positioning as the original, unless it can be shown that greater reliability can be obtained by changing the positioning		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. The final positioning consideration which is actually a dictating factor is the actual space provided for the component. This factor is particularly prevalent in micro-electronics where there is often only enough space for the component to be mounted in one way		
2. Lead terminations		
a. All of the various lead termination styles you have learned in previous training will be found in micro-electronic assemblies		
b. In addition to those you are familiar with, there are some new style terminations which are very common to micro-electronic assemblies		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. The first of these is the type used in conjunction with lap-soldered joints		
d. The next type found in some styles of vertical component mounting is called multilead circuit board connections. This is a form of hollow standoff with a solder cup used to connect several leads to the same point		
e. The preferred style of lead termination for through-board solder joints is the straight through termination. This is to allow maximum repairability of the circuits during future maintenance		
3. Lead cutting	3. Display slide YXP L9-S12	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. All lead ends must be cut with a flush cutting tool		
b. Scissors are the most highly recommended tool for cutting flat leads such as those on a flat pack IC, and for cutting the leads on multilead components		
(1) Scissors are ideal for cutting the leads of multi-lead components since they permit all leads to be cut in a single operation. This will provide a high degree of uniformity in lead length		
(2) They are also very good for flat leads since they allow them to be cut with a minimum amount of torque applied to the lead. This is very important since flat leads are easily distorted by very small amounts of torque		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. All other leads may be cut with standard flush cutting pliers		
4. Specifications and standards	4. Display slide YXP L9-S13	
a. All component mounting and lead termination specifications previously learned apply to microelectronic repair		
b. The mounting specifications for IC May be summed up in one statement, mount it the same as the original. This is because the multilead IC packages do not permit any variation jn the physical mounting of the component		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. The specifications for a lap-solder joint lead termination is as follows:		
(1) The lead must be flush cut, with the cut being perpendicular to the long axis of the lead		
(2) No portion of the lead may extend beyond the edge of the mounting pad		
d. The specifications for a multiple lead termination will be as follows:		1333

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) All leads must enter the solder cup on a line parallel to the long axis of the solder cup		
(2) Lead ends shall be bottomed in the solder cup		
(3) All lead ends shall be cut to a length so that the lead bend, which is nearest to the solder cup, begins not less than one lead diameter above the top edge of the solder cup when the lead is bottomed in the solder cup		
e. On lead termination standard which you have previously been taught is highly important and should be re-emphasized due to its effect on the repairablility of micro-electronic assemblies. The standard pertains to straight through terminations		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) In a straight through termination the lead end must extend a minimum of one lead diameter beyond the board surface and a maximum of two lead diameters		
(2) The lead end should never be cut flush with the surface of the circuit board (despite the original design) unless a protruding lead end will cause electrical contact with adjacent assemblies		
C. High-Reliability Micro-Miniature Soldering Techniques		
1. Through-board soldering		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. The soldering iron is the most effective tool for making through-board solder joints		
b. For maximum reliability a through-board solder joint should be completed with 3 seconds after application of heat. This can be accomplished by selecting the proper combination of temperature and tip mass		
c. A reliable through-board solder joint is formed by using the following techniques		
(1) Thoroughly clean all items which will contact or become part of the solder joint		

1338

1338

692

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Apply liquid flux to the joint area on both sides of the board		
(3) Apply the iron tip to contact both the lead and pad area		
(4) Form a heat bridge with solder		
(5) Apply solder to the connection in sufficient quantity for it to flow through the hole and complete the joint on both sides of the board in a single operation		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(6) Thoroughly clean the connection after soldering		
d. When soldering multilead components, use a skipping pattern to prevent excessive heat buildup in a single area of the board or component		
2. Lap joint soldering		
a. You are familiar with making lap-soldered connections on circuit conductors using a soldering iron. The use of the special lap flow soldering tool and the installation of lap-soldered ICs will be new to you, however		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The following steps should be used to reliably form lap-solder connections		
(1) Prior to lap soldering a connection, the solder pads should be cleaned and tinned	(1) Display slide YXP L9-S14.	
(2) Component leads should also be tinned prior to soldering (particularly if they are gold plated).		
(3) Properly position the IC and tack solder two opposite corners down to hold the component in place	(3) Display slide YXP L9-S15.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Apply liquid flux to all connection points and solder each lead in place. Solder will not normally need to be added if pads are pretinned correctly	(4) Display slide YXP L9-S16.	
(5) Do not forget to resolder the two tack soldered corner leads after all other leads have been soldered. Remember, also, to skip around when soldering leads so that there is no excessive heat buildup in one area		
(6) After soldering throughly, clean all solder connections		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Lap-soldered clearance hole connections such as those shown in this slide may also be made with the lap flow soldering tool. NOte the excessive solder quantity on connections	c. Display slide YXP LS-S17.	
3. Soldering multiple lead joints		
a. Multiple lead connections are soldered with the same techniques as those used on connector pins		
b. Great care must be taken when soldering this type of connection to prevent head damage since it has a relatively large mass which requires considerable heat in solder		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. It is highly recommended that heat shunts be used when soldering this type of connection		
D. Use and Capabilities of Soldering Tools		
1. Soldering iron		
a. The soldering iron has the capability of soldering any type of soldered connection as you have learned		
b. It is only necessary to learn to select the proper tip and temperature setting to gain this versatility		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Although capable, the soldering iron is not always the easiest and most efficient soldering tool to use. Some special application soldering tools will be discussed next		
2. Lap flow soldering tool		
a. The tool may solder anything from a standard flat lead to a single small strand of wire.	a. Display slide YXP L9-S18.	
b. The proper use of the lap flow tool in making a lap-soldered connection is as follows:		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Set the temperature of the lap flow tool (using a practice board) so that the solder on the connection will completely melt in less than 3 seconds		
(2) Apply the tip of the tool to the connection to be soldered, using the tip to hold the lead in the proper position		
(3) Depress and hold the footswitch until the solder has melted and flowed over the connection. (Add a small quantity of solder if needed)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Keeping the tip in place, release the footswitch and allow the solder to solidify. The lap flow tip is a rapid cooling, non-solderable metal which will not stick to, or damage, the connection.		
c. The tip of the lap flow tool is spring-loaded to prevent excessive pressure from being applied to the joint during soldering		
3. Hot air jet soldering		
a. It is also possible to perform soldering with the hot air jet on very small connections and on lap soldered joints		

107

1357

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The method is exactly the same as for desoldering with the hot air jet except that the lead is pressed into the solder when it melts rather than lifted out of the solder		
c. This method is only recommended for use when the connection to be soldered is known to be highly susceptible to damage from contact pressure during soldering		
E. Solder Joint Inspection		
1. Acceptance standards		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. You have previously learned the acceptance criteria for all types of printed circuit solder joints except for the lap-soldered connection		
b. The acceptance standards for lap-soldered connections is as follows		
(1) The outline of the component lead must be plainly visible through the solder	(1) Display slide YXP L9-S19.	
(2) The solder must thoroughly cover the pad area, lead surface, lead end, and lead edges		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) A smooth concave fillet must be formed from the pad to the lead end, lead edges, and the underside or heel of the lead bend		
NOTE: The fillet at the heel of the lead bend provides the majority of the solder connections strength		
(4) A smooth gleaming surface finish free of any defects with two exceptions		
(a) A depression in the surface of the solder on top of the lead is permissible if the lap flow tool was used to make the connection		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) Small frosty areas on the surface of the solder are permissible if the lead was gold-plated		
2. Rejection standards		
a. The rejection criteria for all connections except lap-soldered joints is the same as those you have learned in previous training	a. Display slide YXP L9-S20.	
b. The rejection standards for lap-soldered connections are as follows:		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Insufficient solder which occurs when the concave fillets fall below a line drawn from the pad surface to the top edge of the lead at a 45-degree angle		
(2) Excessive solder which occurs if the outline of the component lead is not clearly visible, and if any fillets are not concave		
(3) Solder spillage over the edge of the solder pad		
(4) No fillet on the heel of the lead bend		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Dewetted areas on any part of the lead or solder pad		
(6) Excessive frosty appearance of the solder surface on a gold plated lead. This indicates that enough gold is present in the joint to seriously detract from its strength		
(7) Any evidence of internal solder bonding defects such as pits, cracks, roughness, etc.		
(8) The connection is also unacceptable if the lead bends or positioning is incorrect		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Visual indications		
a. All of the defects described may be detected visually by the indications described in this lesson and those taught to you in previous training		
b. When visually inspecting microminiature solder connections it may often be necessary to use the microscope to reliably check for defects due to the small size of the connection		
c. The following slides will show some defective lap soldered connections		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) The module in this slide was repaired by an untrained technician. Note the left IC of the center row	(1) Display slide YXP L9-S21.	
(2) As this close up view of the IC, which was replaced, shows nearly any defect possible may be found in these connections	(2) Display slide YXP L9-S22.	
(3) Another example of repairs attempted by untrained personnel. Note the IC at the bottom right corner.	(3) Display slide YXP L9-S23.	
(4) This slide clearly speaks for itself (or perhaps the proper word is shouts) as to the quality of the lap-soldered connections	(4) Display slide YXP L9-S24.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
F. Applying Conformal Coatings		
1. Surface preparation		
a. There are several thousand different coatings on the market today, and it is totally impractical to try and teach you the proper surface preparation for each type		
b. The proper requirements for cleaning and preparation are provided with each coating and if followed explicity will give reliable results		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Application techniques		
a. Coatings may be either sprayed, poured, or brushed on		
b. The type of coating, the desired thickness, and the size of the area to be coated will determine which method should be used		
c. When applying coatings always follow these basic rules		
(1) Never apply the coating thicker than the original		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Never apply a coating of a different type from the original		
(3) Always apply carefully so that there are no bubbles or uncoated spaces in the coating		
3. Curing methods		
a. As with preparation methods, there are a multitude of curing methods and it is best to follow the curing directions provided with each coating		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. The curing time of nearly all coatings may be speeded up by heat, however, remember that the recommended curing temperature of a coating must NEVER be exceeded, and that a module should not be released from the repair shop until the coating has cured completely.		
G. Safety Precautions	G. Display slide YXP L9-S31.	
1. Workpiece		
a. Follow proper workpiece handling procedure at all times		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Never perform an action which willdegrade or damage the workpiece		
c. Perform all work to the best of your capabilities		
2. Tool		
a. Properly maintain and handle all tools		
b. Use all tools ONLY for their intended purpose		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Personal		
a. Exercise the proper safety precautions for all of the following potentially dangerous items which you will be working with		
(1) Electrically powered tools		
(2) Edged tools		
(3) Rotating tools		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(4) Hot tools		
(5) Caustic, toxic, and flammable chemicals and materials		
H. Demonstration		
1. Micro-electronic soldering of IC's	1. Instructor should demonstrate the proper techniques and use of tools while showing the students how to install micro-electronic components (IC's) on single and double sided circuit boards as covered during the lesson.	1. Observe and ask questions if necessary.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. APPLICATION		
Performance Sheet 4-4-1P	Supervise each student's completion of 4.4.1P, emphasizing safety	Complete 4-4-1P. Ask questions if procedures are not clear.
IV. SUMMARY		
A. Introduction	A. Emphasize importance of the summary for the student.	
1. Nature of summary.		
2. Purpose of summary.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Directions to students.		
1. Questions		
2. Notes		
C. Recap of lesson. Completed during demonstration.	C. Emphasize safety	C. Ask questions if material not clear; check notes to insure accuracy and completeness.

V. INFORMAL TEST

There is no informal test for this lesson topic. It has been provided for through the implementation of Part III, "Application."

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
VI. ASSIGNMENT		
Read and study 4.4.1N in student guide.	Provide students with the homework assignment.	Ask questions if the assignment is unclear. Complete assignment.

6/L

720

STUDENT'S GUIDE
FOR
MINIATURE/MICROMINIATURE ELECTRONIC REPAIR (2M) PROGRAM

PREPARED BY
FLEET TRAINING CENTER
NORFOLK, VIRGINIA 23511

A-100-0034

PREPARED FOR
CHIEF OF NAVAL TECHNICAL TRAINING

MARCH 1977

TABLE OF CONTENTS

FRONT MATTER

PAGE
Table of Contents - v
How to Use This Guide - vii
Instruction Sheets - vii
Related Materials - vii

OUTLINE OF INSTRUCTION

1-2-1A Introduction to the Course - - - - - - - - - - - - - - - - 2
1-2-1N Introduction to the Course - - - - - - - - - - - - - - - - 3
1-3-1A Introduction to High Reliability Soldering - - - - - - 7
1-3-1N Introduction to High Reliability Soldering - - - - - - 8
1-4-1A Preventive Maintenance of the 2M Repair Station - - - 23
1-4-1J Preventive Maintenance of the 2M Repair Station - - - 24
2-1-1A Printed Circuit Board Component Installation and Soldering - 25
2-1-1N Installation and Soldering of Printed Circuit Components - 26
2-2-1A Conformal Coating Removal - - - - - - - - - - - - - - - - 39
2-2-1N Conformal Coating Removal - - - - - - - - - - - - - - - - 40
2-2-1I Conformal Coating Removal - - - - - - - - - - - - - - - - 46
2-3-1A Desoldering Printed Circuit Board Components - - - - - 49
2-3-1N Desoldering and Removing Components - - - - - - - - - 50
2-4-1A Repair of Damaged Printed Circuit Boards - - - - - - - 63
2-4-1N Repair of Damaged Circuit Boards - - - - - - - - - - - 64
3-1-1A Soldering to Turret Terminals - - - - - - - - - - - - - 74
3-1-1N Hand Soldering Turret Terminals - - - - - - - - - - - 75
3-1-1I Electrical Wire Splicing - - - - - - - - - - - - - - - - 85
3-2-1A Soldering to Hook and Pierced Tab Terminals - - - - - 88
3-2-1N Hand Soldering Hook and Pierced Tab Terminals - - - - 89
3-3-1A Soldering to Bifurcated Terminals - - - - - - - - - - 95
3-3-1N Hand Soldering Bifurcated Terminals - - - - - - - - - 96
3-4-1A Soldering Connector Pins - - - - - - - - - - - - - - - - 106
3-4-1N Solderable Connector Pins - - - - - - - - - - - - - - - 107
4-1-1A Introduction to Micro-Electronic Circuit Boards - - - 115
4-1-1N Introduction to Micro-Electronic Circuit Soldering - - 116
4-1-1I Publications for use in Miniature/Micro-miniature Repair - 119
4-2-1A Microminiature Repair Task Identification and Procedural Analysis - - - - - - - - - - - - - - - - - - 121
4-2-1N Micro-Miniature Repair Task Identification - - - - - - 122
4-3-1A Micro-electronic Circuit Conformal Coating Removal and Desoldering Techniques - - - - - - - - - - - - - - - 130
4-3-1N Micro-Electronic Circuit Conformal Coating Removal and Desoldering Techniques - - - - - - - - - - - - - - 131
4-4-1A Micro-Electronic Circuit Soldering Techniques - - - - 140
4-4-1N Micro-Electronic Circuit Soldering Techniques - - - - 141

Note: Lesson 1-1-1A and parts of the front matter have been omitted because of military specific materials.

HOW TO USE THIS GUIDE

This Student's Guide, which is your personal copy, has been prepared to assist you in your study of the Miniature/Microminiature Electronic Repair (2M) Program as presented in Course A-100-0034. Its primary purposes are:

1. to provide the material required during the course that will promote optium development of your technical completence, as it applies to technical knowledge, maintenance tools and maintenance routines.
2. to provide sufficient reference material that will enable effective use of the appropriate specifications and publications.
3. to provide self-help materials.

INSTRUCTION SHEETS

Assignment Sheets - These sheets are provided for all topics. They contain outside reading and/or written work when it is considered necessary. The assignment sheet contains the objectives for the topics. They can become an effective "learning tool" if you apply yourself diligently in completing the assignments. Included on these sheets are thought-provvoking questions covering the major points of the assignment

Notetaking Sheets - These sheets are provided for most topics. In addition to preprinted matter in outline form, the notetaking sheets contain ample blank space for personal notes. Properly completed, they can be very useful for review of the topic at a later date.

Job Sheets - These sheets are provided for topics which require you to perform a physical skill such as operating the equipment. These sheets contain step-by-step instructions, or references to the appropriate manual, to guide you in performing the job.

RELATED MATERIALS

MIL-STD-454D, Electronic Equipment
MIL-S-45743C, Soldering Manual Type, High Reliability, Electrical, Electronic Instrument, Communication and Radar for Radar and Aerospace and Control System
NHB 5300.4(3A), Requirement for Soldering Electrical Connections
MIL-STD-275C, Printed Wiring for Electronic Equipment

The Pace Rework and Repair (R&R) Technology Series Volumes 1, 2, 3, 4, 5, 6, 7 and 8 dated 1971

ASSIGNMENT SHEET 1-2-1A

TITLE

Introduction to the Course

OBJECTIVE

When you complete this lesson topic, you will be able to:

1.2.1 COMPLY with classroom procedures, regulations, schedules, scholastic requirements and special instructional activities in accordance with information outlined in the Student's Guide.

STUDY ASSIGNMENT

Read and study Notetaking Sheet 1-2-1N of the Student's Guide.

STUDY QUESTIONS

None

NOTETAKING SHEET 1-2-1N

TITLE

Introduction to the Course

REFERENCES

NOTETAKING OUTLINE

A. Purpose of the course

1. To provide maintenance personnel with the latest methods to disassemble, repair and solder miniature printed circuits, components, terminals, solderable connectors, circuit board laminates and conductors to replace electronic components on microminiature single and double sided printed circuit boards and the proper preventive maintenance procedures for the repair station and its associated components.

B. Course Objectives

1. REPLACE component parts on printed circuit boards using the correct tools and soldering techniques and apply the proper conformal coating in accordance with the procedures and to the standards outlined in MIL-STD-454D and MIL-C-47256 (MI).

2. REMOVE conformal coatings from printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in VOLUME 6 of the PACE Rework and Repair Technology Series.

3. REMOVE printed circuit components parts using the correct tools and desoldering techniques following the procedures and to the standards outlined in Volume 6 of the PACE Rework and Repair Technology Series.

4. REPAIR damaged printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in MIL-STD-454D.

5. CONNECT wires to turret terminals, hook and pierced tab terminals, bifurcated terminals and connected pins using the proper tools and soldering techniques following the procedures and to the standard outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4(3A).

6. REPLACE component parts on micro-electronic printed circuit boards using the correct tools and soldering techniques and apply the proper conformal coating in accordance with the procedures and to the standard outlined in MIL-STD-454D.

7. REMOVE conformal coating from micro-electronic printed circuit boards using the proper tools and techniques following the procedures and to the standards outlined in Volume 6 of PACE Rework and Repair Technology Series.

8. REMOVE micro-electronic printed circuit board component parts using the correct tools and desoldering techniques following the procedures and to the standard outlined in Volume 6 of the PACE Rework and Repair Technology Series.

9. PERFORM preventive maintenance on the 2M Repair Station following the procedures and to the standards outlined in the applicable technical manual.

C. Reason for the course

1. Despite component reliability 1,000 times better than in the past, circuit density has increased 100,000 times. Consequently we have an ever increasing number of component failures to deal with.

2. Even with the increasing failure rate, approximately 80% of the failures occurring today happen to assemblies which have been previously repaired. This shows that during some part of the repair cycle the assembly is being damaged or degraded in some manner.

3. A large part of the damage and degradation can be traced to a lack of correct training and equipment. Because of this lack, most technicians are causing serious degradation to the assemblies they repair, resulting in an increased failure rate and a much shorter assembly lifetime.

4. Before today's highly sophisticated electronic systems were developed, the soldering program, at both the manufacturing end and in repair, was quite lax.

5. Thus, to achieve a repair reliability in keeping with modern component reliability, this course was devised to teach you, the repair technician, the latest and best high-reliability repair techniques.

E. Course Schedule

1. First week Printed Circuit maintenance
2. Second week Terminals and Connector Pins
3. Third week Micro-miniature Printed Circuit Soldering

Note: Sections D and F have been omitted because of military specific materials.

G. Safety

1. Personal
    a. Handle and store heat tools properly to avoid burns.
    b. Handle and store pointed and edged tools properly to avoid cuts.
    c. Be extremely careful of rotary tools, particularly when using cutting bits.
    d. When using rotary tools always use eye protective goggles.
    e. Avoid prolonged skin or breathing contact of all chemicals used in the course.

f. Avoid all eye, mouth, and open cut contact with chemicals used in the course.

g. Do not breath dust particles from cutting and grinding operations.

h. Avoid any possibility of igniting flammable chemicals or materials.

i. Teflon releases toxic fumes at 400 degrees F. Be especially careful when thermally stripping wire as the element exceeds 400 degrees F and will cause fuming of Teflon insulation.

j. Use common electrical safety to avoid shocks.

k. Do not heat solvents. Some solvents release toxic fumes when heated. (For example, Chlorine and Phosgene gas)

2. Equipment

a. Never perform any action on the workpiece that will cause damage or degradation.

b. Handle all workpieces as though extremely fragile.

c. Maintain cleanliness at all times.

d. NEVER put enough strain on rotary tools to make them load down or bind.

e. NEVER drop or bang an electrical power tool.

f. Check all electrical cords for damage from hot tools, solvents or abrasion.

g. Properly clean all tools and store in the proper place.

h. Use each tool only in the manner for which it was designed to be used.

H. Work Station Inventory

a. Instructor will point out all tools and materials in the workstation.

ASSIGNMENT SHEET 1-3-1A

TITLE

Introduction to High Reliability Soldering

OBJECTIVES

When you complete this lesson topic, you will be able to:

1.3.1 IDENTIFY the characteristics of high reliability solder connections which include soldered area, solder quantity, solder finish, wetting and solder defects. Identification will be in complete agreement with the information contained in MIL-STD-454D and NHB 5300.4(3A).

1.3.2 OBSERVE all applicable equipment and personnel safety precautions, throughout the entire course of instruction, in accordance with the safety outlined in NASA Handbook SP-5002. (1.8)

STUDY ASSIGNMENT

Read and study Notetaking Sheet 1-3-1N of the Student's Guide.

STUDY QUESTIONS

1. Describe the identifying characteristics of Eutectic solder.

2. Solder is an intermetallic bond created by __________ action.

3. A solder connection having a slight grainy and lumpy appearance is an indication of ____.

4. What is a "fractured solder joint"?

5. At what temperature does 60/40 solder liquify?

6. A preferred solder connection forms a concave fillet from a point __________ way up the side of the lead.

NOTETAKING SHEET 1-3-1N

TITLE

Introduction to High Reliability Soldering

REFERENCES

MIL-STD-454D
NHB-5300.4(3A)
Federal Specification QQ-S-571E
MIL-S-45743C

NOTETAKING OUTLINE

A. Characteristics of solder and solder bonding

1. Analysis of solder composition

a. Solder is a metal alloy consisting of two or more metals used in various percentages to form the solder alloy.

b. The various elements which may be used to make up solder are listed below, along with their chemical symbols;

(1) Tin-Sn

(2) Lead-Pb

(3) Silver-Ag

(4) Antimony-Sb

(5) Bismuth-Bi

(6) Copper-Cu

c. Bismuth and antimony are added to solder in very small percentages for special purpose applications, and only in very rare instances will alloys containing these metals be used as electronics solders.

d. Copper is sometimes added to solder to saturate the alloy with copper molecules and thus slow down the solders solvent action (called solder washing) on soldering iron tips; (the solvent action of solder will be explained later in this lesson).

e. Silver is sometimes added to solder to achieve the same slowdown of solder washing on silver-plated nonsolderable surfaces of certain components such as ceramic capacitors.

f. The solder most commonly used in electronic soldering will be an alloy of tin and lead without special additives.

(1) The two most common alloys are 60/40 and 63/37

(2) Tin/Lead solder alloys are always given as a percentage with the tin content listed first, e.g., 60/40 is 60% tin and 40% lead.

2. The effects of heating and cooling on solder.

a. The diagram in Fig. 1 shows a plot of various tin/lead solder alloys versus temperature.

(1) Note that at 361°F, all tin/lead solders from a range of 15/85 to 95/5 change from a solid to a plastic (partial liquid) state except one.

(2) An alloy which has a single sharp melting point and changes directly from a solid to a liquid with no plastic state is called an EUTECTIC alloy. The only tin/lead solder alloy with eutectic characteristics is 63/37, as the diagram shows. The 63/37 solder is known as eutectic solder.

(3) Also notice that the different alloys reach full liquid state at different temperatures.

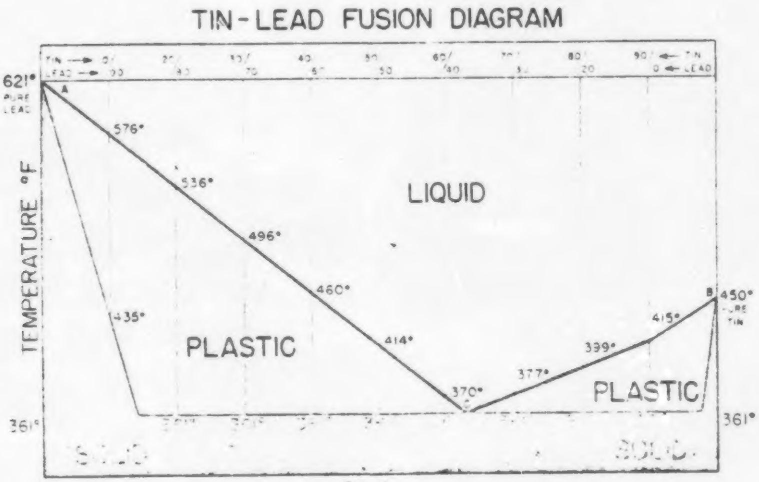


Fig 1

The Tin-lead Fusion Diagram

b. An overall evaluation of the diagram shows that as solder is heated, it passes from a solid state through a plastic state and into a liquid state, with the exception of the eutectic point at which there is no plastic state.

c. The most critical area of concern during a soldering operation is the time-temperature range during which the solder is in a plastic state.

(1) While in a plastic state the solder is a combination of a liquid tin/lead alloy in combination with solid pure metal crystals of either tin or lead.

(2) The particular alloy being worked with, in relation to the eutectic point, will determine whether the solid crystals are pure tin or pure lead.

(3) If the alloy is lead-rich in relation to the eutectic point, the crystalline structure will be of pure lead.

(4) If the alloy is tin-rich in relation to the eutectic point, the crystalline structure will be of pure tin.

(5) Any physical movement of the solder itself, while cooling through the plastic state, will permanently damage the intermolecular crystalline structure of the solder alloy, resulting in a fractured solder connection.

(6) For this reason eutectic solder, 63/37, is the best general purpose, high-reliability, electronic solder.

(7) 60/40 solder, which is also highly acceptable for electronic soldering, has the advantage of forming a slightly stronger joint than 63/37 solder. 60/40 solder, however, has the disadvantage of having the plastic range from 361°F to 370°F, and the resulting chance of fractured solder connections.

3. Soldering flux: Types, Purpose, Characteristics, and Effects on intermetallic bonds through wetting action.

a. Soldering fluxes may be divided into three general types or classifications.

(1) Chloride (commonly called acid) type flux.

(2) Organic type flux.

(3) Rosin or resin type fluxes.

b. The purpose of soldering flux is to remove surface oxides from metals to be soldered.

(1) All metals oxidize when exposed to air.

(2) The process of oxidation causes a thin film of oxide, which is nonmetallic, to form on the surface of the metal.

(3) Good metal-to-metal contact must be obtained before soldering action may take place, and the oxide film prevents metal-to-metal contact.

(4) Flux chemically breaks down surface oxides causing the oxide film to loosen and come free from the metals being soldered.

c. Each group of fluxes has characteristics which are specific to that group.

(1) The chloride fluxes are inorganic salts and are the most active of the three flux groups. They are effective on all common metals except aluminum and mangesium, but are not suitable for fine electronic soldering since they are highly corrosive, usually electrically conductive, and difficult to remove from the workpiece.

(2) The organic fluxes are nearly as active as inorganic fluxes and they are less corrosive and easier to remove than inorganic fluxes. They are still not satisfactory for electronic soldering because they must be removed completely to prevent corrosion and because they have an extremely short lifetime at high temperatures.

(3) Rosin-type flux is ideally suited to electronic soldering due to its unique characteristics. The molecular structure of rosin, while inert at normal temperatures, breaks down and becomes highly active at soldering temperatures. This characteristic makes rosin totally noncorrosive, except at soldering temperatures. In addition, rosin is nonconductive, having 3.3×10^{15} (3,300 trillion) ohms per cubic inch resistivity. Resin fluxes are rosin based, with additives that change some of the characteristics of the pure rosin flux.

d. In addition to removing oxides, a good soldering flux must also aid in forming the intermetallic solder bond by improving the wetting action of the solder.

(1) Flux aids wetting action primarily by lowering the existing surface tension between the metals being soldered and the liquid solder.

(2) Some improvement to wetting action is also given by the floating action of the flux which causes loosened oxides to be carried away from the solder flow path.

e. To attain highest reliability in making electronic solder joints, the use of flux is a necessity.

f. Flux is available as both an external agent and as an integral part of the solder.

g. As an external agent the flux is applied to the connection by hand prior to soldering.

(1) External fluxes will range from a very thin liquid to a thick heavy paste.

(2) Most paste fluxes contain zinc chloride as an activating additive. If zinc chloride has been added, it will be stated on the container.

(3) Fluxes containing zinc chloride should NEVER be used for high-reliability soldering since they ARE corrosive.

(4) Zinc chloride also gives off highly toxic fumes when heated to soldering temperatures.

h. Nearly all electronics solder in use today contains flux as an integral part of the solder.

(1) Flux is made an integral part of the solder by making the solder with a flux core.

(2) There are four standard flux core sizes as specified in Federal Specification QQ-S-571E, which are: 4.5%, 3.3%, 2.2%, and 1.1% by volume.

(3) The flux content of solder is measured in percentage by volume and, for a given core type, will remain a constant percentage regardless of solder gage.

i. It is permissable and often highly desirable to use an external flux in conjunction with flux-cored solder.

j. Two types of external flux are recommended for high-reliability electronic soldering by Military Specification MIL-S-45743C.

(1) Kester Solder Co. No. 1544, with No. 104 thinner.

(2) Alpha Metals Co. No. 711, with No. 412 thinner.

k. In addition to wire-type solder which is most often used in repair, there are special preforms and shapes of solder available.

(1) Solder preforms are for applying precise amounts of solder to a particular type of connection on a repetitive basis, such as in manufacturing production lines.

(2) They are also used in production when the connection is not accessible by hand when it is soldered, such as sealed cans and evacuated atmosphere units.

(3) The special forms are quite expensive and not normally needed for repair work, but the repair technician should be aware of their availability should the need for their use arise in special cases.

(4) The forms are available as both flux-cored and as solid solder.

(5) A wide range of special preforms of solid flux similar to the solder preforms are also available for special application use.

l. Detailed specifications and standards for fluxes and flux-cored solders may be found in the following publications:

(1) Federal Specification O-F-506-B

(2) Federal Specification QQ-S-571E

(3) Military Specification MIL-S-6872A

(4) Military Specification MIL-F-14256C-1

(5) Military Specification MIL-F-20329A

(6) Military Specification MIL-S-45743C

4. The intermetallic bond and wetting action.

a. Solder does NOT act as an adhesive or glue in bonding metals together.

b. Solder forms an actual intermetallic bond with solderable metals, but it does NOT do so by fusion as in brazing or welding where all metals to be bonded must be molten to fuse together.

c. The intermetallic bond formed by solder is a solvent or solution action.

(1) An illustration of this solution action can be shown with plastics which will melt at a fairly high temperature, but will dissolve at room temperature when placed in a solvent such as acetone.

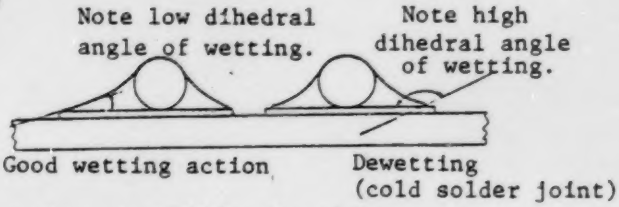
(2) This dissolving action is the method by which solder forms an intermetallic bond (solution) with copper and other metals that are solderable, much the same as with acetone on plastic.

(3) The bond formed by solder is then a completely new alloy consisting of solder (tin and lead) in solution with the metal being soldered.

(4) The soldered connection is a single complete piece of metal even though it does consist of at least three separate alloys (the base metal, the base metal and solder, and solder).

d. The wetting action of solder is the degree of ease and completeness with which the solder spreads over the surface of the metal being soldered.

e. The completeness of the wetting action is measured by the tangent angle where the solder meets the surface of the metal being soldered, called the dihedral angle of wetting.


Note low dihedral angle of wetting.
Note high dihedral angle of wetting.
Good wetting action
Dewetting (cold solder joint)

(1) A very small angle is an indication of thorough and complete wetting.

(2) A large angle formed by a sphere or bubble of solder (similar to a drop of water on a waxed car hood) is an indication of poor wetting.

f. The completeness of the wetting action is one of the prime indicators of quality and reliability when inspecting a solder joint.

B. Metallic platings

1. Purpose of platings

a. It is the function of platings to protect the metal they cover by preventing oxidation.

(1) The prevention of oxidation also keeps the base metal in a clean and highly solderable condition.

(2) One of the best platings for prevention of oxidation is gold, as it is the lowest of the electromotive series of elements. Gold is quite porus, however, and must thus be applied in a relatively thick layer to accomplish its job.

b. Plating is also used on component leads which are made of a nonsolderable metal.

(1) Some nonsolderable metals are used to make component leads where they are needed to obtain special strength, flexibility, and thermal expansion characteristics.

(2) In this case the lead is plated with a solderable metal so that it may be soldered into a circuit.

(3) When this situation exists, care must be taken not to damage or remove the plating from the base metal.

2. Effects of plating on the intermetallic bond.

a. To understand the effects of plating, it is necessary to understand that platings form a physical attachment with the base metal and NOT a metallic alloy.

b. Thus, soldering to the plating metal alone becomes unsatisfactory as no true intermetallic bond is established with the base metal.

c. One solution to this problem is to remove the plating from the area to be soldered as part of the soldering preparation.

(1) This may be done by using a rubberized abrasive such as a typewriter eraser if the plating is a soft metal such as gold. This method will only work where surface shape and spacing make it practical.

(2) If the plating is hard or the surface is very irregular, removal of the plating may be accomplished by tinning heavily with solder and then removing the solder. Since the solder has alloyed with the plating metal, most of the plating metal will be removed along with the solder. It may be necessary to perform this operation several times to gain satisfactory plating removal, thus making heat tolerance a prime consideration when using this technique.

d. Another method of obtaining a good intermetallic bond on a plated surface is to apply sufficient heat and time for the solvent action of the solder to penetrate through the plating and form an alloy with the base metal. While this method will work with most platings there are other factors to be considered.

(1) The method does not work well with very hard plating metals due to the slower solvent action of the solder.

(2) The plating must be relatively thin for this method to work reliably.

(3) The alloy of the plating metal with the solder will, in some cases, cause the solder bond to lose strength or become brittle.

e. The best solution to plating problems is being used by manufacturers. They are starting to hot-dip base metals in solder rather than electroplating them.

(1) This works very well since the coating forms an actual intermetallic bond with the base metal rather than just a physical coating.

(2) This coating is naturally the easiest to solder to since you are, in effect, merely adding solder to an already established solder bond.

(3) Since this method can only be put into use at the manufacturing level, it is only necessary for the repair technician to be aware of its purpose and effects.

3. Determining if a plating will be harmful or advantageous to a connection.

a. Only two platings, other than hot-dip solder, are commonly used on areas to be soldered.

(1) These two platings are gold and silver.

(2) Many other platings are used in electronics, but they are used either in extremely rare instances or in areas which will not be soldered to, such as printed circuit edge connectors.

b. Silver is used primarily on terminals and connector pins.

(1) The shape and accessibility of such objects makes plating removal impractical and thus requires that the soldering operation take place with the plating intact.

(2) Silver wets and alloys well with solder, and does not detract from joint strength, so it has no harmful effect on the intermetallic bond.

c. Gold is the most common plating metal and is used extensively on all types of electronic circuitry.

d. Gold plating may be either very harmful or highly advantageous to soldering depending upon the specific purpose and area where it is used.

(1) Gold plating is very advantageous when used on a nonsolderable component lead since the component could not be soldered into a circuit without the solderable gold plating. For this reason it is necessary to take care in keeping the plating on component leads intact.

(2) Gold plating on areas such as printed circuit runs, pads, and eyelets is normally harmful to solder connections as it detracts from the solder joint reliability.

e. There are several detrimental effects caused by gold when it is present in the solder connection in quantities greater than 5% by weight.

(1) Pull test results show the effect of reduced solder bond strength.

(a) Pull separation strengths were measured between a copper wire soldered to a gold-plated copper run and a copper wire soldered to an unplated copper run.

(b) The bond with gold present had only a little over half the strength of the bond with no gold.

(c) The loss of strength is due to the gold which is alloyed with the solder. The portion of the solder which has gold dispersed through it becomes the weakest part of the bond.

(d) The bond with no gold present separates at the thinnest point of the connection, as should be the case with any good strong intermetallic bond.

(e) The bond which contains gold separates at the surface of the copper run where the heaviest concentration of gold is present.

(2) Gold is also detrimental in that it causes the solder bond to become brittle.

(a) A brittle solder bond is highly undesirable since it is subject to cracking under stress such as the thermal expansion and contraction common to electronic circuits.

(b) The brittleness is caused by the porous nature of gold which is not lost when it forms an alloy with solder.

(c) A visual indication of this is usually present in the form of a rough "frosty" solder connection appearance.

(3) The final detrimental effect of gold on a solder bond is that of decreased wetting action.

(a) This is evidenced by a very high dihedral angle of wetting.

(b) The result is a reduced spread area of the applied solder.

f. The detrimental effects of gold on a solder connection make it necessary to remove gold plating from a connection area, whenever possible, before soldering.

C. Characteristics and fabrication of a quality solder joint

1. Physical appearance

a. The most obvious visual indication of a quality solder joint is a smooth and shiny mirror-like surface.

b. The joint surface must be totally free of any pits, protrusions, or other blemishes.

c. There must be no copper showing through the soldered area at any point.

d. The solder will form a smooth concave fillet between the component lead and the surface it is soldered to at all points of the soldered area.

e. The most critical indication of quality and reliability of a soldered connection is the wetting action of the solder.

(1) There must not be any distinct inlets at the edge of the soldered area where the solder did not flow.

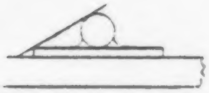
(2) The solder must wet and blend smoothly into the soldered surfaces at the edge of the soldered area leaving no sharp edge or ridge at any point where the solder has stopped flowing.

2. Solder quantity

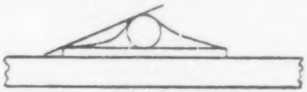
   a. The preferred quantity of solder on a connection.

      (1) The solder forms a smooth concave fillet from a point about one half of the way up the side of the lead.

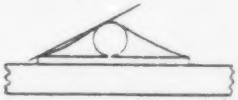
      (2) The contour of the wire is clearly visible through the solder (if the wire is stranded, the individual strands must be visible).



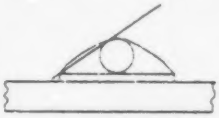
Below minimum allowable reject



Preferred



Maximum allowable solder



Excess solder reject

   b. The maximum acceptable quantity of solder on a connection.

      (1) The solder fillet starts about three-fourths of the way up the side of the lead.

      (2) The connection is very near to having too much solder since the fillet is only slightly concave.

   c. An excessive quantity of solder on a connection.

      (1) The fillet is convex rather than concave.

      (2) It is not possible to tell if the lead is even in the solder joint since it is completely hidden by the solder.

      (3) It is possible for many defects, such as air pockets, to exist within the joint and not show through to the solder surface.

   d. An insufficient quantity of solder on a connection.

      (1) The fillet, although concave, starts well below the halfway point of the lead.

      (2) Even though the intermetallic bond is good, there is not enough of it to withstand vibration and expansion stresses. This would result in solder cracking and assembly failure within a short time.

3. Internal structure

   a. The internal metallic structure of a good solder connection consists of several different alloys.

b. The following list would be the alloys that make up a solder connection between a tinned copper lead and a copper printed circuit pad.

(1) Solid copper forming the pad.

(2) Copper, tin and lead alloy on the surface of the pad.

(3) Tin and lead alloy in the center of the joint.

(4) Copper, tin, and lead alloy on the surface of the component lead.

(5) Solid copper forming the component lead.

c. All of the alloys must be complete with no air pockets, foreign substances, or other solder defects in the joint to obtain a reliable internal structure.

d. The only positive tests of the internal structure are X-raying or destructive examination, neither of which is practical for the repair technician.

e. The repair technician must judge the internal quality of the joint by learning the external appearance of defects and their causes.

D. Recognition and causes of solder-joint defects.

1. Description of common defects.

a. NASA lists over 40 different solder-joint defects.

b. All of these defects fall under five major categories, and a knowledge of these five categories is sufficient for the repair technician.

c. The most common defect is a dirty solder joint which has a good outward appearance except for its wetting action.

(1) The edges of the solder will show a lack of good wetting action, also known as dewetting.

(2) Very distinctive of this type of defect is the indication that only one portion of the soldered area shows dewetting, usually less than one-half of the circumference.

(3) In the dewetted area there will usually be small inlets going back into the solder where it did not flow.

d. Another common defect is the cold solder joint which also has a good outward appearance except for its wetting action.

  (1) The dewetting seen in this type of defect differs from that of the dirty joint in that it usually has dewetting around all or most of the soldered surface.

  (2) An additional indication which may be present is a small protrusion or tip of solder sticking up from the surface where the soldering iron tip was removed from the joint.

e. Another defect is the fractured or disturbed solder joint.

  (1) The surface is usually semishiny and there is good wetting.

  (2) The prime indication of this defect is a spider-webbed or cracked, fissured appearance to the surface of the solder.

  (3) On some occasions large cracks may appear around component leads.

f. The next type of defect is an overheated solder joint (often mistakenly called a cold solder joint even though the appearance is quite different).

  (1) The surface of this joint is generally quite dull.

  (2) The prime indication of this defect is a rough, grainy, or sandy appearance.

  (3) The appearance may be lumpy rather than sandy if overheat is just beginning.

g. The last defect category is dead solder, which has indications very unique and different from any other type.

  (1) The first indication is a crusty or wrinkled appearance as if there is a film over the solder surface.

  (2) The solder will be a very dark dull color and may have faint light and dark streaks in it.

2. Causes of common defects.

  a. The dirty solder joint is caused by oxidation or other foreign matter interfering with the wetting action of the solder.

b. The cold solder joint is caused by insufficient heat applied or poor transfer from the tip of the soldering iron.

c. The fractured solder joint is caused by physical movement of the solder while it is cooling and changing from a liquid to a solid.

d. The overheated solder joint is caused by applying too much heat for too long of a time.

e. Dead solder is a condition of a very extreme overheat in which the tin and lead components of the solder may acutally begin to separate, and is generally only seen in solder left on the tip of the iron when not in use.

ASSIGNMENT SHEET 1-4-1A

TITLE

Preventive Maintenance of the 2M Repair Station

OBJECTIVES

When you complete this lesson topic, you will be able to:

5.1.1 PERFORM daily preventive maintenance actions on the SX-200 Solder Extractor following procedures outlined in the technical manual.

5.1.2 SERVICE hot cubby unit daily as outlined in the PACE Maintenance Manual for the SX-300 System.

5.1.3 INSPECT and CLEAN the Moto Tool as required to remove all foreign matter.

STUDY ASSIGNMENT

None

STUDY QUESTIONS

None

JOB SHEET 1-4-1J

TITLE

Preventive Maintenance of the 2M Repair Station

INTRODUCTION

The purpose of this job sheet is to provide the student with guidance and "hands-on" experience in performing preventive maintenance on the 2M Repair Station so that he might be able to perform related associated duties aboard his duty station.

REFERENCES

PACE 810-001	SODR-X-TRACTOR SX300 General Operating and Maintenance Instructions

EQUIPMENT AND MATERIALS

MERP/2M Equipment Kit

JOB STEPS

1. Perform step 2a and 2b listed on page 17 of the SODR-X-TRACTOR SX300 General Operating and Maintenance Instructions.

SELF-TEST ITEMS

None

ASSIGNMENT SHEET 2-1-1A

TITLE

Printed Circuit Board Component Installation and Soldering

OBJECTIVES

When you complete this lesson topic, you will be able to:

2.1.1 POSITION components on single and double sided printed circuit boards, using preferred mounting as outlined in MIL-STD-454D.

2.1.2 SHAPE component leads for mounting on printed circuit boards without damaging leads or components and meeting all bend specifications as listed in MIL-STD-454D.

2.1.3 REPLACE electronic components on printed circuit boards utilizing the proper tools and soldering techniques for high quality printed circuit solder connections following the procedures and to the standards as outlined in MIL-STD-454D.

2.1.4 INSPECT printed circuit solder connections on selected boards and DETERMINE that quality and reliability are in accordance with the standards outlined in MIL-STD-454D.

2.1.5 IDENTIFY the conformal coating application techniques that should be used on various repaired printed circuit boards. Identification will be in complete agreement with the information contained in MIL-C-47256(M.I.).

STUDY ASSIGNMENT

Read and study Notetaking Sheet 2-1-1N of the Student's Guide.

STUDY QUESTIONS

1. What techniques are used for applying conformal coatings on printed circuit boards? ______________, ______________, ______________

2. What is the minimum distance from the component body to the start of the bend in the component lead?

3. Disregarding all characteristics except cleaning ability, what is the most preferred solvent for general purpose cleaning?

NOTETAKING SHEET 2-1-1N

TITLE

Installation and Soldering of Printed Circuit Components

REFERENCES

MIL-STD-454D
MIL-C-47256(M.I)

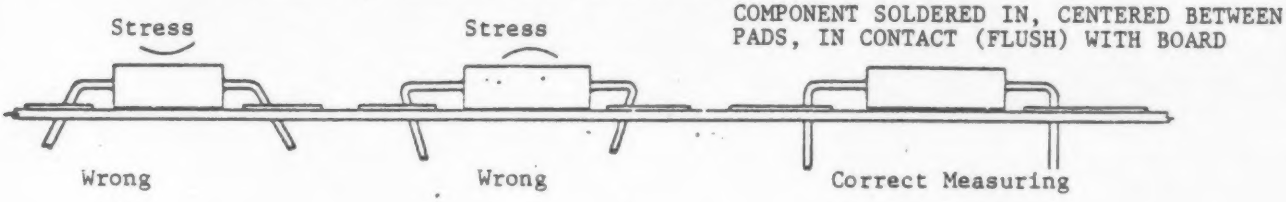
NOTETAKING OUTLINE

A. Proper positioning of a component on a printed circuit board

1. Specifications and standards

a. In repair, replacement components should always be installed in conformance with the original configuration.

b. Component bodies shall be centered between the component lead mounting points whenever design permit, and flush mounting is the preferred method.


Stress
Stress
COMPONENT SOLDERED IN, CENTERED BETWEEN PADS, IN CONTACT (FLUSH) WITH BOARD
Wrong
Wrong
Correct Measuring

c. Replacement components shall be mounted so as to make all possible identification markings readable without disturbing the component.

d. When a series of components are mounted in the same style and direction, they should be placed so that the markings on all are readable from a single point (giving due regard to polarity requirements).

e. Any mounting hardware removed during disassembly shall be replaced when installing new components.

2. Considerations to be made.

a. The following considerations take mandatory precedence over preferred mounting styles.

(1) Proper mounting of polarized components

(2) Physical space limitations of original design.

b. When mandatory mounting considerations have been met, preferred configurations should be used.

B. Methods of shaping component leads for mounting on a printed circuit board.

1. Specifications and standards.

a. Component leads shall always be straightened and cleaned prior to shaping.

b. Leads may be straightened by hand using anything that will NOT cut or scrape the lead.

c. Eraser cleaning of leads is preferred.

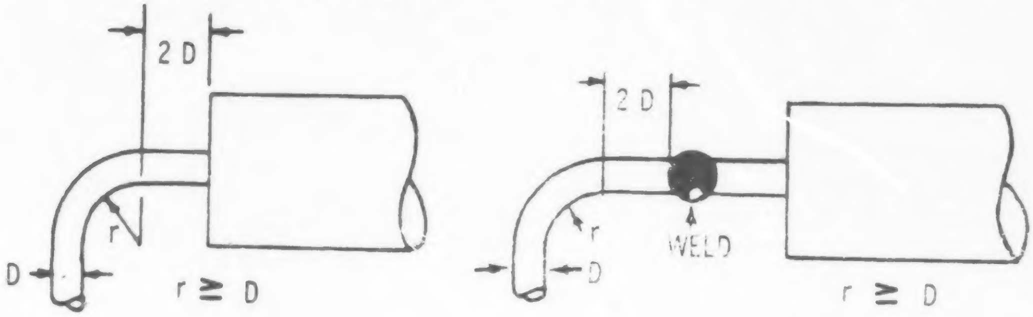
(1) Use an ink-type eraser (white) for this purpose as other types of erasers will leave an oily film on the lead.

(2) After cleaning the leads with any method, the final cleaning step should be to wipe the lead thoroughly with solvent to remove any particles left by the other cleaning method.

d. The minimum distance between the seal, where the lead enters the body of the component, and the start of the lead bend shall be NO LESS than a distance equal to twice the diameter of the lead itself.

e. The minimum distance between any weld bead on the lead and the start of the lead bend shall be NO LESS than a distance equal to twice the diameter of the lead itself and the bend shall NOT be between the weld bead and the component body.

f. The minimum radius of the bend itself (sharpness of the bend) shall be NO LESS than a distance equal to the diameter of the lead, and the bend angle shall be 90 degrees at all times, except when forming a stress relief bend.



(a) STANDARD LEAD (b) WELDED LEAD

MINIMUM LEAD BEND

g. After bending leads, and before inserting the component on the board, always re-clean the leads with solvent to remove any skin oils and salts present due to finger contact.

h. After installing the component on the board, the proper lead termination must be made prior to soldering.

  (1) Prior to shaping lead termination, excess lead can be cut off with a flush-cutting tool.

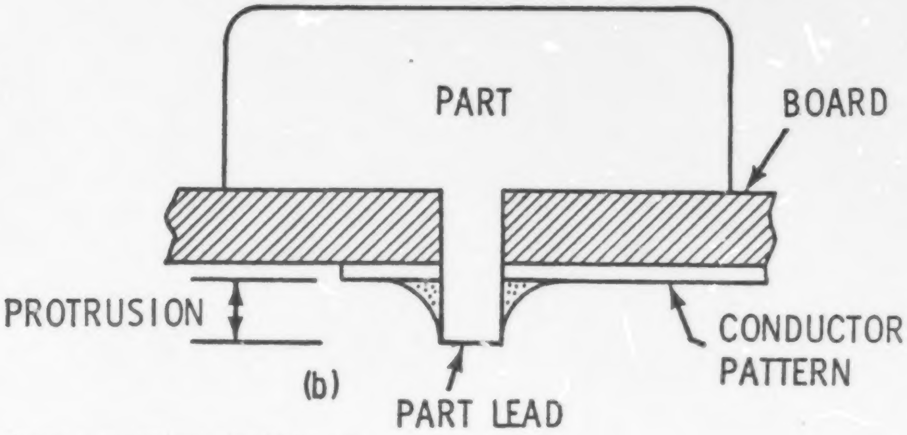
  (2) On clinched terminations the lead length shall be not less than the radius of the pad and not greater than the diameter of the pad.

  (3) Semiclinched terminations have the same length specifications as full clinches.

  (4) All clinched terminations must be bent in the direction of a run.

  (5) Full clinch terminations must contact the run surface and not overhang any part of the run edge.

  (6) The lead length of straight-through terminations shall be not less than one lead diameter and not more than two lead diameters above the board surface.



i. Proper shaping techniques

  (1) The first step in preparing for component installation is to thoroughly clean the circuit board.

    (a) A white ink type eraser will remove light oxides and gold platings.

(b) Heavy oxides and thick platings may be removed with mechanical abrasion.

(c) Always clean the board with solvent and a kimwipe after abrading and DO NOT let the solvent evaporate, but wipe it away with a clean DRY kimwipe.

(d) Solvent cleaning may also be done with a brush. Always use a brush which has soft bristles to prevent scratching the conductor surfaces, and remember to wipe dry with a kimwipe.

(2) The next operation in component installation is cleaning and bending the component leads prior to insertion in the board.

(a) A nylon rod or orangewood stick may be used to bend component leads. Be sure to always hold the component body immobile and bend only the pigtail end of the lead with a smooth wiping motion of the finger.

(b) When using round nose pliers to form 90 degree bends and stress relief loops, always use EXTREME care not to dent the component lead.

(c) The initial step in forming stress relief loops is to make a standard 90 degree bend in the lead.

(d) To finish the stress relief bend, grip the lead just beyond the 90 degree bend, and wipe the pigtail end smoothly around the plier jaw, forming a 180 degree loop

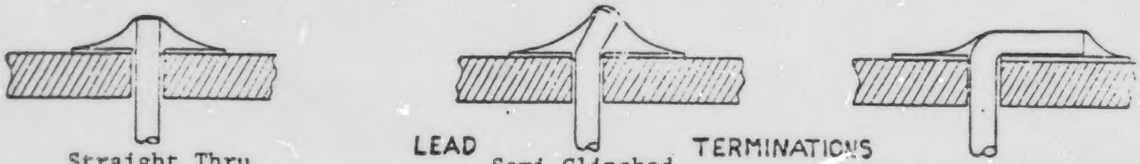
(e) The COMFORM1 tool is one of many types of special lead forming tools.

(f) Special tools, such as the COMFORM1 tool, may be used to measure proper component lead spacing. The sliding post must be locked into place with the setscrew after the posts are inserted into the component mounting holes.

(g) The upper forming posts of the COMFORM1 tool reflect the measured lead spacing. The component is inserted into the forming posts and the leads are then wiped firmly against the side of the forming post.

j. After bending and inserting the component into the board, the next step is to properly form the lead termination.

(1) If forming a straight-through termination, the lead is simply cut to proper length with flush-cutting pliers.



LEAD TERMINATIONS

Straight Thru   Semi Clinched   Full Clinch

(2) To form a semiclinched termination, grip the lead end with pliers and bend in the direction of a run to a 45 degree angle, without PULLING on the lead.

(3) After bending, the lead is cut with flush-cutting pliers. The flush side of the cutter is ALWAYS kept towards the board.

(4) For full clinch leads, the bending and cutting process is the same as for semiclinch leads.

(5) An orangewood stick, which will not damage the board in any way, may be used to fully clinch the pigtail down to the run surface.

k. Characteristics of high quality printed cirucit solder connections.

(1) The soldered area extends beyond the cut end of full clinch leads sufficiently to form a fillet.

(2) The solder must flow to the edges of the pad in all cases.

(3) If the run or pad is plated and plating has been removed, solder shall be flowed over ALL exposed base metal.

(4) On a single sided board the solder forms concave fillets between the lead and pad with no internal voids.

(5) On a double-sided board with plated-through holes or flat-set eyelets, the solder should completely fill the hole and cover the pads on both sides of the board.

(6) The soldered area of a funnel-set eyelet forms three separate solder joints; one on each side between the outer flanges and the pad, and one through the hole between the inside of the eyelet and the lead.

(7) Solder finish and wetting.

(a) The solder finish must exhibit the following characteristics

1. A smooth gleaming mirror-like appearance

2. No pits or holes

3. All fillets must be concave

(b) Solder wetting characteristics must be as follows

1. The edges of the solder flow must blend smoothly into the soldered surface with no ridged or bubbled appearance.

2. There must be no bays or crevices extending back into the solder flow.

l. Techniques for making high quality printed circuit solder connections.

(1) Application of flux

(a) Only flux-cored solder should be used, as it provides automatic application of flux to the connection while soldering.

(b) For large areas or rapidly oxidizing surfaces a quantity of external flux may also be applied to the joint prior to soldering.

(2) Proper heating

(a) Proper heating can only be accomplished with a correctly prepared soldering iron.

1. A typical soldering iron used in high reliability soldering has different tip sizes which are used for different masses to be soldered.

2. The tip should be inserted to the bottom of the hole and the setscrew tightened gently, as excessive force will cause the screw to heat-sieze.

3. Dressing soldering iron tips

a. Copper tips should be dressed with a smooth file, only when cold, to prevent oxidation and solder repulsion.

b. When using a plated copper tip, never dress the tip with a file. Clad tips should be cleaned only with a platers brush, or crocus cloth if heavily oxidized.

4. After cleaning or dressing the tip, it MUST be tinned by flowing a generous amount of new solder onto the SHAPED surface as soon as the iron is hot enough to melt solder. The iron is then allowed to idle for approximately 2 minutes until it reaches full operating temperature, at which time additional solder is added.

5. The solder is left on the tip if the iron is not going to be used immediately. This protects the hot tip from the rapid oxidizing effects of heat.

6. Before using the soldering iron to make a solder joint, all excess solder must be removed from the tip with a brush and kimwipe.

7. If the iron has idled for some time, fresh solder should be added to the tip prior to wiping off excess solder, this ensures that any impurities will flow to the surface of the solder and be removed during the wiping action.

8. After the excess solder has been wiped off, thermal shock the tip on a wet sponge to provide a clean, dry tip for soldering.

9. The thin plating (tinning) slows down oxidation and aids in heat transfer to the connection when soldering.

(b) To achieve proper heating of the connection, the tip size and the wattage of the element must be capable of rapidly heating the mass of the joint being soldered to the melting temperature of a solder.

(c) When soldering a small mass connection, the applied heat may be controlled by either decreasing the power to the iron with the variable AC control or by decreasing the size of the tip.

(3) Application of solder

2. The iron should not be moved during the soldering operation, even on double sided boards, since proper cleaning and heating of the joint area will allow the solder to flow through the hole and form the entire joint with a single application (except for holes without metallic reinforcement).

3. Solder is applied to the connection by painting the solder onto the area to be soldered using a circular motion. Start by forming fillets along the sides of the lead and tinning the cut end of the lead; finish by filling in the large flat area of the pad.

(4) Cleaning after soldering.

(a) After the soldering operation is completed all flux residues must be removed by solvent cleaning.

(b) The flux residue may be removed using solvent and a kimwipe or a bristle brush.

(c) Do NOT allow the solvent to air-dry on the board as it will leave a thin layer of flux residue behind.

(d) Many solvents are approved for circuit board cleaning. The four most highly recommended solvents in order of their overall cleaning effectiveness are:

1. 99.5% pure ethyl alcohol

2. 99.5% pure isopropyl alcohol

3. 1.1.1 trichlorethane

4. Freon TF

m. Inspecting completed printed circuit board solder connections for quality.

1. Standards of acceptance

(a) The solder joint must possess the proper quantity of solder.

(b) The solder finish must show no evidence of defects.

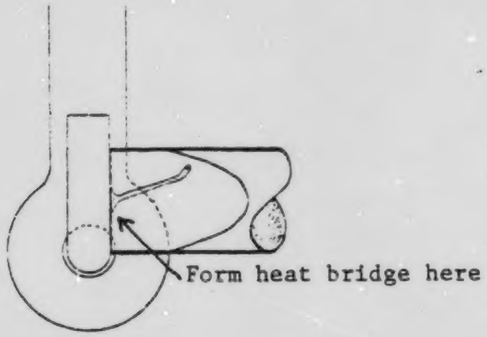
755

(a) Before applying heat a thermal shunt should be attached to component leads if dealing with heat sensitive components such as diodes and transistors.

  1. Care must be taken not to solder a copper thermal shunt into the circuit.

  2. When component leads do not provide access for the thermal shunt attachment due to the use of mounting hardware, EXTREME care must be used to prevent heat damage. Some heat protection is provided by the mounting hardware and the additional lead length.

(b) A solder bridge is formed by melting a small amount of solder at the junction of the tip and the joint. This forms a large area intermetallic bond between the tip and the joint, effectively making the tip a part of the joint and allowing maximum possible heat transfer rate from the tip to the joint.



(c) After the prepared tip is placed in physical contact with both the lead and the pad and the heat bridge has been established, the solder must be applied to form the solder bond.

  1. Use only clean solder.

(c) Proper solder wetting action.

(d) Proper lead termination styles.

(e) No board, conductor, or component damage.

(2) Indications to look for.

(a) Solder quantity

1. Concave fillets

2. Lead contour visible

(b) Solder finish

1. Bright, gleaming finish

2. No pits or holes

(c) Wetting action

1. Smooth feathering of all solder edges.

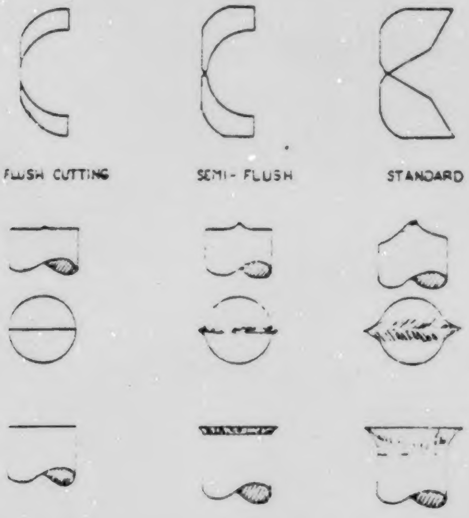
2. No bays or crevices in the edge of the solder flow.

(d) Lead termination

1. Proper length

2. Proper positioning

3. Pigtail properly flush-cut



TYPES OF PLIER CUTTING JAWS AND RESULTING CUTS

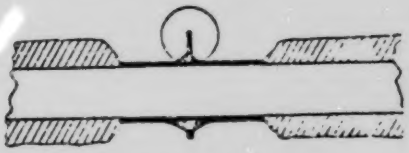
757

(e) Board, conductor, and component damage

- 1. Overheated board
- 2. Conductor delamination
- 3. Conductor nicks and scratches
- 4. Proper component installation

(3) Reasons for rejection

- (a) Insufficient solder quantity
- (b) Poor wetting
- (c) Excessive solder quantity
- (d) Lead cut wrong
- (e) Disturbed solder
- (f) Overheated solder
- (g) Fractured solder
- (h) Cold solder
- (i) Dirty solder
- (j) Dead solder
- (k) Copper exposed at the cut end of the lead



Re-install component, ensuring all specifications are met.

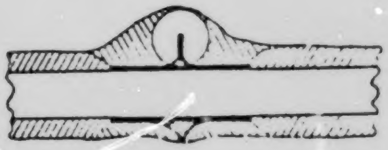
n. Applying a conformal coating to a repaired printed circuit board

(1) Preparation

- (a) All dirt, grease, and other foreign matter must be removed.
- (b) The board must be thoroughly dried and free of any dampness.

(2) Application techniques

- (a) Dipping
- (b) Brushing
- (c) Spraying



Replace conformal coating, ensuring a complete seal to component and old coating.

- (3) Curing the coating
  - (a) Never cure any coating below normal room temperature
  - (b) Follow the manufacturer's directions for best results

o. Final inspection of a repaired printed circuit board

- (1) Standards of acceptance
  - (a) Board restored to its original configuration
  - (b) No visible degradation to any part of the assembly
  - (c) The conformal coating (if any) intact with no voids or imperfections
- (2) Indications of reliability
  - (a) Repair made with the same type components and materials as used by the manufacturer
  - (b) Repairs made should be nearly indistinguishable by visual inspection, unless they distinguish themselves by being of a visibly higher quality than the original work of the manufacturer.

p. Safety precautions

- (1) Workpiece
  - (a) Never perform any action on the workpiece which will cause damage or degradation
  - (b) Handle all workpieces as though extremely fragile
  - (c) Maintain scrupulous cleanliness at all times
- (2) Tool
  - (a) Clean and store all tools properly
  - (b) Never use excessive force on any tool
  - (c) Use each tool only in the manner it was designed to be used
- (3) Personal
  - (a) Beware of burns from all hot tools

(b) When using chemicals beware of skin, eye, and internal contact, and avoid excessive inhalation of fumes.

(c) Use eye protection when using power tools and when there is a chance of splashing chemicals.

(d) Avoid any possibility of igniting flammable chemicals or materials.

ASSIGNMENT SHEET 2-2-1A

TITLE

Conformal Coating Removal

OBJECTIVES

When you complete this lesson topic, you will be able to:

2.2.1 IDENTIFY the basic types of conformal coatings listed in Volume 6 of the PACE Rework and Repair Technology Series and MIL-I-46058C, without error.

2.2.2 DETERMINE the proper conformal coating removal method to be used on selected printed circuit boards. Determination will be based on information contained in Volume 6 of the PACE Series.

2.2.3 REMOVE various conformal coatings from printed circuit boards using the chemical, heat, and abrasive methods and proper tools necessary as outlined in Volume 6 of the PACE Rework and Repair Technology Series.

STUDY ASSIGNMENT

Read and study Notetaking Sheet 2-2-1N of the Student's Guide.

STUDY QUESTIONS

None

NOTETAKING SHEET 2-2-1N

TITLE

Conformal Coating Removal

REFERENCES

PACE Rework and Repair Technology Series, Volume 6

NOTETAKING OUTLINE

A. Characteristics and recognition of common conformal coatings.

   1. The six basic types of conformal coatings

      a. Epoxies

      b. Acrylic lacquers

      c. Polyurethanes

      d. Varnishes

      e. RTV (Room Temperature Vulcanizing) materials

      f. Parylene

   2. Methods of indentifying type of coating by characteristics.

      a. Each type of coating has specific characteristics of hardness, heat resistance, adhesion, solvent reaction, texture and brittleness.

         (1) In addition to the above characteristics, coatings are classed as being either thick or thin.

         (2) A thin coating is considered to be 0.025 inches or less in thickness. All coatings thicker than 0.025 inches are classed as thick coatings.

      b. Individual characteristics may overlap or appear to be the same; however, overall characteristics evaluation will determine the coating type.

   3. Specific characteristics of the six basic coatings.

      a. Epoxy

         (1) Epoxy is normally the hardest of the six types.

         (2) The application of heat at or near the solder melting temperature causes the epoxy to overcure, resulting in a breakdown into a powdery substance.

(3) Epoxy forms the strongest surface adhesion bond of all of the conformal coatings. It will not chip or peel and may be considered nearly unbreakable under physical stresses.

(4) Very few solvents will attack epoxy, and the ones that do will also attack the components and circuit boards themselves in most cases. Therefore, solvent removal of epoxy coatings is NOT a recommended procedure and should be avoided. The cleaning solvents recommended in a previous lesson will normally not have any effect on epoxy coatings.

(5) The texture of epoxy is normally hard, smooth, and nonporous, much as an extremely hard plastic.

(6) Epoxy is normally very brittle, but due to its great adhesion strength, it does not chip or crack without the application of extreme stress.

b. Acrylic lacquer

(1) Acrylics are relatively hard and similar in appearance to epoxies, but they yield more readily to scraping and cutting.

(2) Heat readily softens most acrylics; however, it often results in a gummy residue.

(3) The adhesion of acrylics is usually a surface bond only and will often chip and flake, although it is relatively strong.

(4) Solvents, such as 1.1.1 trichlorethane and xylene readily attack and soften most acrylics.

(5) The texture of acrylics is normally smooth, nonporous, and of medium hardness with a glossy finish similar to automotive lacquer paints.

(6) Acrylics are quite brittle and chip readily, but due to their brittleness do not exhibit a tendency to peel in large flakes.

c. Polyurethane

(1) Polyurethane coatings are found with widely varying degrees of hardness which range from an extremely hard type, which is similar to epoxy, to a relatively soft consistency which is similar to an RTV compound.

(2) Upon application of heat, at or near solder melting temperatures, most polyurethanes tend to soften rapidly and become easily pliable exhibiting a putty-like consistency.

(3) Polyurethanes normally form a medium-strength surface bond which has a tendency to peel or flake in larger pieces than acrylics.

(4) Plastic solvents are generally the only type solvents that will attack polyurethane, and these will normally also attack the components and board. The cleaning solvents recommended in a previous lesson will normally not have any effect on polyurethane coatings.

(5) The texture of polyurethane is normally smooth, glossy, and nonporous, but MAY be dented or scratched with light pressure such as a fingernail.

(6) Polyurethanes are not brittle, and bend readily, causing them to tear or stretch rather than crack or break.

d. Varnish

(1) The hardness of varnish will vary with age; new varnish is relatively hard and tough while old varnish tends to be brittle and flake very easy.

(2) When heat at or near solder melting temperature is applied to varnish, it liquifies and gives off a very strong and distinctive odor of linseed oil.

(3) The adhesion of varnish coatings tends to be a surface bond that will peel readily, but cracks often.

(4) Organic solvents such as alcohol and mineral spirits readily attack varnish, however, these solvents leave a gummy residue on the board upon evaporation.

(5) The surface texture of varnish is often rather lumpy in appearance and has a semiglossy look.

(6) Varnish is relatively brittle, therefore it flakes rather than peels.

e. RTV's

(1) RTV's have a rubbery, pliable consistency.

(2) Heat, except in excessive amounts or for long durations, has little effect on most RTV's.

(3) RTV's will be found to have a wide variety of adhesion strengths which range from readily peelable to extremely tightly bonded to the coated surface.

(4) Common solvents have no appreciable effect on RTV coatings, although some may cause the surface to feel as if it has been greased with a slick lubricant.

(5) The texture of RTV is smooth, dull, and rubbery.

(6) RTV's are not at all brittle and stretch rather than chip or break.

f. Parylene

(1) Parylene is considered to be a hard coating, and is normally as hard as epoxy.

(2) Heat, approximately 480-500°F, applied with a hot knife will remove parylene; however, the chance of damage to the board is very high at this temperature.

(3) The adhesion of parylene provides a tough pinhole free coating of uniform thickness that is very tightly bonded to the coated surface.

(4) Parylene has no reaction to normal solvents.

(5) The texture is smooth and dull, and normally clear.

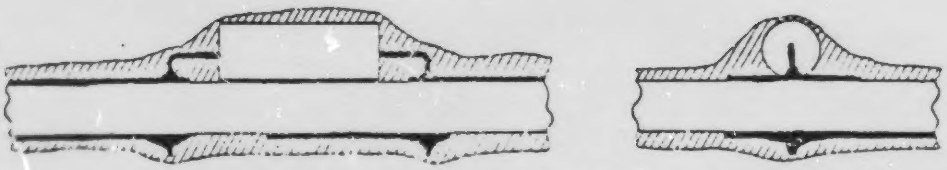
(6) Parylene is not brittle at all, and bends very easily.

B. Coating removal area

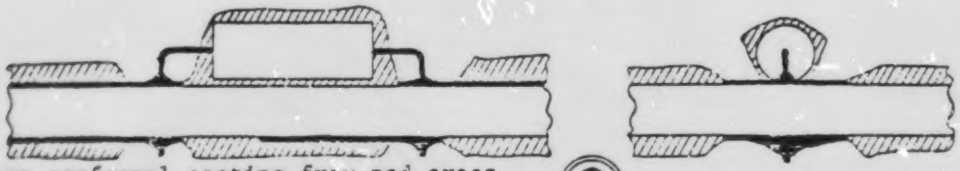
1. The areas from which the coating MUST be removed in preparation for component removal from the circuit board are

a. Remove the coating from all lead/pad areas on both sides of the board. This will allow for free airflow through the mounting holes during desoldering of the leads.

b. Remove the coating along all sides of the component to a point ON OR BELOW the widest profile of the body. Do NOT try to remove the coating all the way down to the board surface due to the chance of damage to the board.



Problem: Remove bad component from heavy conformal coating on a double sided G-10 board with plated thru holes. ①



Remove conformal coating from pad areas on both sides of board (To ensure air flow for complete solder removal and cooling.) ②

C. Methods of removing conformal coatings

1. Chemical removal

   a. Chemical removal consists of the removal of coatings using solvents.

   b. The only coating which is readily removable with solvents is acrylic lacquer applied in a relatively thin coating (less than 0.025 inches).

   c. Chemical removal procedures consist of the following steps:

      (1) Apply the chemical solvent sparingly.

      (2) Apply the solvent only to the area from which the coating MUST be removed.

      (3) For best results the solvent should be applied with a small brush or swab.

      (4) The solvent should be blotted up continuously to prevent its spreading into undesired areas and to allow new solvent to attack the newly exposed lower areas of the coating.

      (5) Do NOT allow prolonged soaking in solvent, to prevent possible damage to the printed circuit or components.

2. Handtool removal

   a. Handtool removal consists of the removal of coatings using controlled heat, scraping, and peeling.

   b. Coating removal by controlled heat is effective on epoxies and polyurethanes.

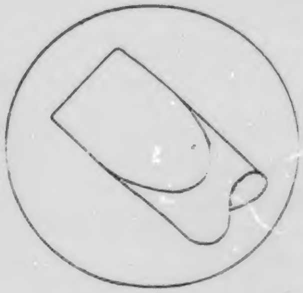
   c. Scraping and peeling removal is effective on some polyurethanes and most RTV compounds.

3. Power tool removal

   a. Power tool removal consists of the removal of coatings by using abrasive grinding and abrasive cutting methods.

   b. Coating removal by abrasive cutting methods is effective on all coatings applied in a thick layer (greater than 0.025 inches).

   c. Abrasive grinding removal techniques are effective on all thinly applied coatings.



Slightly round off corners to help prevent gouging of board during coating removal operations.

INFORMATION SHEET 2-2-1I

TITLE

Conformal Coating Removal

INTRODUCTION

This information sheet is an aid to the student in determining the type of conformal coating and the best method for removing it.

REFERENCES

MIL-STD-454D, Military Standard for Electronic Equipment
MIL-C-47255, Coating, Protective for Printed Wiring Board
Volume 6, of the PACE Rework and Repair Technology Series

INFORMATION

The accompanying charts are to be used to help determine the type of coating and the best method for removing the coating.

CHART 1 - This chart shows the types of coatings and a list of characteristics that must be tested for. By matching the observed characteristics with the chart, you should be able to readily determine the type of coating on the printed circuit board under test.

CHART 2 - This chart shows the types of coatings and a list of the methods that may be used for removal of coatings. The methods are numbered for each type with the best (safest) method as the lowest and the least desirable (most dangerous) as the highest.

SUMMARY

The use of these charts should enable the student to identify and remove conformal coatings correctly. It is important to remember that any of these methods of conformal coating removal can cause damage to the workpiece, and must be used with care.

CONFORMAL COATING CHARACTERISTICS

	HARD	MED. HARD	SOFT	HEAT REACTION	SURFACE BOND VERY STRONG	SURFACE BOND STRONG	SURFACE BOND MEDIUM	SURFACE BOND LIGHT	SOLVENT REACTION	SMOOTH SURFACE	LUMPY SURFACE	NONPOROUS SURFACE	GLOSSY SURFACE	SEMI-GLOSSY	DULL SURFACE	RUBBERY SURFACE	BRITTLE	CHIPS OFF	PEELS & FLAKES	STRETCHES	SCRATCH & DENT BEND & TEAR
EPOXY	X			X	X					X		X	X	X			X	X			
ACRYLIC LACQUERS		X		X		X			X	X		X	X				X	X	X		
POLYURETHANES	X	X	X	X			X			X		X	X						X	X	X
VARNISH	X	X		X		X			X		X			X			X		X		
R.T.V.			X		X	X	X	X		X					X	X				X	X
PARYLENE	X				X					X		X			X				X		X

1442

CHART 1

1443

768

REMOVAL TECHNIQUE

CONFORMAL COATING

LISTED IN DESCENDING ORDER OF HARDNESS	SOLVENT	ROTARY BRISTLE BRUSH	GRIT IMPREGNATED RUBBER WHEELS & DISCS	HOT AIR JET & ORANGE WOOD STICK	MODIFIED SOLDERING IRON	BALL MILLS, ETC.	CUTTING AND PEELING	
PARYLENE			2		* 1 (F)	3		
EPOXY		3 (C)	4 (C)	1 * (C)	2 *	5 (B&D)		
ACRYLIC LACQUER	1 *	3	4 (C)	2				
POLYURETHANE	5 (A&C)	3 (C)	4 (C)	1 *	2 *			
VARNISH	1 (A&C)	3	4	2 *				
R.T.V.		2 (C)					1 *	

NOTE: THE PREFERRED ORDER FOR APPLYING INDIVIDUAL REMOVAL TECHNIQUES TO SPECIFIC COATINGS IS NUMERICALLY INDICATED. THESE REMOVAL TECHNIQUES ARE LISTED IN ASCENDING ORDER OF THEIR DAMAGEABILITY TO THE MODULE UNDER REPAIR. ANY OF THE METHODS LISTED MAY CAUSE DAMAGE IF NOT USED WITH CARE. ALWAYS TRY THE LEAST DAMAGE CAUSING METHOD FIRST. CONSIDER THE POSSIBILITY OF HEAT OR VIBRATION SENSITIVITY OF COMPONENTS (VIBRATION EXPECIALLY WILL AFFECT ALL AREAS OF THE WORKPIECE).

*. DENOTES METHOD THAT POSITIVELY IDENTIFIES TYPE OF CONFORMAL COATING.
A. SPECIFIC TYPES OF COATING COMPOSITIONS ONLY.
B. FOR THICK COATINGS (.025 & THICKER).
C. FOR THIN COATINGS ONLY.
D. DO NOT ATTEMPT TO GRIND TO BOARD SURFACE WITH THIS METHOD.
E. ORGANIC SOLVENTS ARE BEST.
F. USE MODIFIED DRILL BIT FOR TIP (SHAPED TO BEVELED EDGE).
CAUTION: USE WITH CARE, APPROXIMATELY 500 DEGREES F NEEDED AT TIP.

CHART 2

ASSIGNMENT SHEET 2-3-1A

TITLE

Desoldering Printed Circuit Board Components

OBJECTIVES

When you complete this lesson topic, you will be able to:

2.3.1 IDENTIFY the various types of printed circuit solder connections by visual inspection of selected printed circuit boards. Identification will be in agreement with the connection listed in Volume 6 of the PACE Rework and Repair Technology Series.

2.3.2 EVALUATE the repair task to be performed and DETERMINE the proper desoldering and component removal method to be used on selected printed circuit boards utilizing information contained in Volume 6 of the PACE Series.

2.3.3 DESOLDER various types of printed circuit solder connections using the wicking, manual vacuum and motorized vacuum extraction methods and proper tools necessary as outlined in Volume 6 of the PACE Series.

STUDY ASSIGNMENT

Read and study Notetaking Sheet 2-3-1N of the Student's Guide.

STUDY QUESTIONS

None

NOTETAKING SHEET 2-3-1N

TITLE

Desoldering and Removing Components

REFERENCES

PACE Rework and Repair Technology Series, Volume 6

NOTETAKING OUTLINE

A. Recognition and characteristics of printed circuit solder-joint types

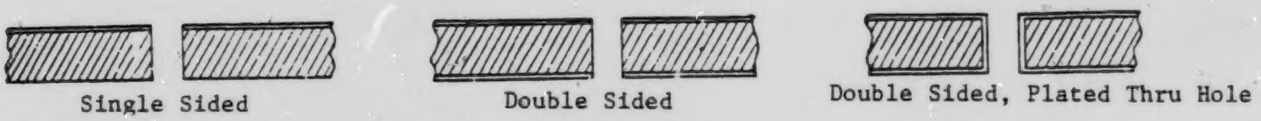
  1. Common joint types

    a. To recognize the various solder-joint types you must take into consideration the board circuitry style, the lead termination style, and the style of hole reinforcement.

    b. Of the three considerations, board circuitry style is the easiest to recognize. It consists of the following:

      (1) A single sided board which has conductors on one side only.

      (2) A double sided board which has conductors on both sides.



BOARD TYPES

    c. The consideration of hole support is generally the hardest to identify because it is often hidden beneath the solder. The various styles of hole support are:

      (1) No hole support, single sided board

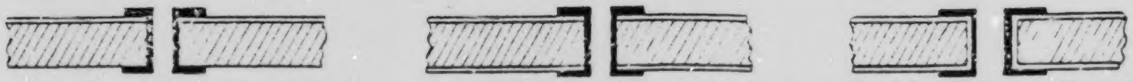
      (2) Plated-through hole, single sided board

      (3) Eyelet, single sided board

      (4) Plated-through hole, double sided board

      (5) Eyelet, double sided board

      (6) Fused eyelet, double sided board

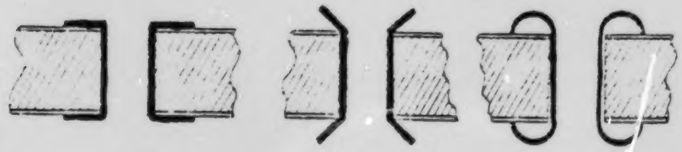


Single Sided, Eyeletted

Double Sided, Eyeletted

Double Sided, Plated Thru w/ Eyelet

EYELETS IN DIFFERENT TYPE BOARDS

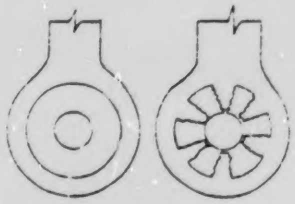


Flat Set

Funnelet

Roll Set

EYELET TYPES
May be found in any combination of head types.



Plain

Petal Set

Any style eyelet may be obtained in both head types.

d. Hole supports normally form "interfacial connections" which are a means of electrically joining the circuitry on double sided boards. The various styles are:

(1) Clinched buss wire, soldered on both sides.

(2) Any type or style of eyelet, soldered to both sides.

e. Component lead termination styles

(1) A fully clinched lead, a common type often used in machine soldering as well as hand soldering.

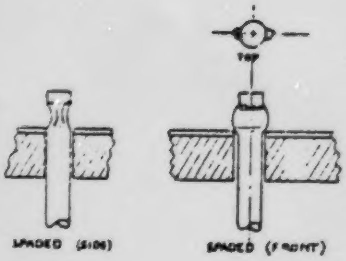
(2) A semiclinched lead, easier to remove during repair than a full clinch lead.

(3) A straight through lead, which provides the greatest degree of repairability.

(4) An offset pad termination which has the hole drilled outside of the pad area.

(5) A crimped lead on the component side which provides component clearance for improved solvent cleaning and air circulation. This also provides clearance to prevent components with a high operating temperature from scorching the circuit board. Note that this is NOT a lead termination but a component mounting method.

(6) A spaded lead termination, in which the end of the lead is crimped after being passed through the printed circuit board. NOTE THAT THIS STYLE OF TERMINATION IS EASILY HIDDEN BY THE SOLDER AND THAT THE LEAD MUST BE CUT BETWEEN THE COMPONENT AND THE SPADED PORTION BEFORE ATTEMPTING TO REMOVE THE LEAD FROM THE HOLE.



(7) A lap solder-joint lead termination is a form or style in which the component lead does NOT pass through the circuit board. Note that a lap joint may be used with both round and flat leads.

2. Identification methods

a. WARNING: When indentifying solder-joint types, you are apt to find several different styles of solder-joint construction on a single printed circuit board.

b. You are also apt to encounter component leads WELDED to the printed circuit board pad or run.

(1) Welded leads MUST NOT be mistaken for solder joints since they CANNOT be removed with a soldering iron.

(2) The fine black line across the component lead is the identifying characterisitc of a welded joint.

(3) Any attempt to remove the lead with a soldering iron will damage the board by overheating, without disturbing the weld.

c. Use the following means to identify board circuitry style:

(1) Inspect visually.

(2) Use a bright light to backlight the board, if needed, to show the relationship of interconnection paths.

d. Use the following means to identify lead terminations style:

(1) Inspect visually

(2) Remove solder from the joint to determine if there are any hidden termination characteristics

e. Use the following means to identify hole support styles:

(1) Inspect visually

(2) Remove all solder from the connection, CAREFULLY, to determine hidden hole reinforcement characteristics.

B. Desoldering methods for printed circuit solder joints.

1. Removal by wicking.

a. Solder removal by the wicking method consists of using finely stranded wire (either braided or twisted) in conjunction with liquid flux and heat to cause all but an extremely thin layer of solder to be removed from the joint

b. Capillary action causes the solder to be drawn up into the wicking material

c. This action is aided by the liquid fluxes ability to increase the wetting action.

2. Manual vacuum extraction.

a. Solder removal using the manual vacuum method consists of a manually controlled and operated one-shot vacuum source in conjunction with heat to create a vacuum airflow which pulls molten solder from the joint.

b. Manual vacuum usually has the advantage of instant vacuum rise time (zero to maximum with no delay).

c. Manual vacuum may have one or more of the following disadvantages:

(1) Extremely high vacuum levels which may cause damage by lifting conductors from printed circuit boards, since the conductor bonding material has greatly reduced strength at solder melting temperatures.

(2) Inability, in some cases, to apply the vacuum tip and the source of heat to the solder joint at the same time.

(3) Short vacuum duration or physical movement of the vacuum tip caused by manual operation of the vacuum source may cause incomplete solder removal, necessitating multiple applications of heat which can result in damage.

3. Motorized vacuum extraction

a. Solder removal using motorized vacuum consists of a continuous vacuum source such as an airbottle and venturi combination or an electrically driven vacuum pump, which provides a continuous vacuum to a heated solder extraction tip and removes molten solder by vacuum airflow.

b. Motorized vacuum is normally controlled by a foot-switch and differs from manual vacuum primarily in that it supplies a continuous vacuum.

c. Motorized vacuum extraction has several advantages:

(1) The vacuum can generally be set at the desired level

(2) The extraction tip and the heat source are usually combined into one tool.

(3) The availability of continuous vacuum allows solder removal with a single application of heat.

d. Motorized vacuum sources may have a vacuum rise time which is slower than desired.

C. Selection and use of desoldering tools.

1. The selection of tools and techniques to be used in a particilar desoldering operation will be determined by the type of solder-joint and lead termination.

2. The tools and techniques chosen MUST be those least likely to cause damage of any nature. To avoid damage, the following factors should be considered:

a. The effect of the chosen technique on the board materials.

b. The effect of the chosen techniques on the circuit conductors.

c. The effect of the chosen techniques on the adjacent components.

NOTE: Testing and evaluation have shown the following techniques have effective and reliable applications. The technician must decide which technique is best for a specific task, keeping in mind at all times the REQUIREMENT of causing NO damage.

D. Inferior methods of solder extraction - solder removal methods which should not be used or which have limited applications.

1. The heat and shake method, which should not be used since it does not remove all solder, and it causes solder to be splattered over other areas of the circuit board.

2. The heat and pull method, which should not be used since hidden component lead terminations may cause damage when pulled through the board.

3. The heat and blow method, which should not be used for the same reasons as the heat and shake method.

4. The squeeze-bulb solder extraction method is inferior due to the tip size, incomplete extraction, and frequent solder spillage onto the circuit board.

5. The spring plunger extractor (solder removal) method has limited application since it does not work well in small areas and does not remove all of the solder.

E. Procedures for wicking solder removal

1. Select a piece of wicking material (braid or stranded wire) which is smaller than the area being desoldered.

2. Dip the wicking material in liquid flux and place it on the area to be desoldered, taking care to ensure that there is no overlap of wicking material onto the board material.

3. Apply a clean, dry soldering iron tip to the braid using GENTLE pressure, without moving the tip around on the braid.

4. The wicking material may be drawn across the area to be desoldered after the solder melts and begins to soak into the wicking material.

5. If solder stops flowing into the wicking material before it has all been removed, or if all of the flux is boiled away before removal is complete, the operation must be repeated being sure to cut off the filled portion of the wicking material to provide a fresh wicking area for absorption of solder.

6. Wicking material works progressively better as the number of strands increases and the size of the strands decreases.

7. The following damages can result by improperly using the wicking method:

   a. Scorching caused by excessive heat and allowing the flux to completely boil away.

   b. Measles caused by allowing hot wicking material to overlap the pad area and contact the board material.

F. Procedures for manual vacuum solder extractor.

1. Apply the soldering iron tip and the extractor tip to the area to be desoldered at the same time. Note that the space to do this is a limiting factor.

2. Upon observing a complete solder melt, press the release trigger which will create a vacuum and cause the solder to be extracted.

3. The extractor must be firmly held to minimize recoil which may cause the extractor tip to jump away from the joint and result in incomplete extraction and the necessity of repeating the operation several times, with the chance of board damage.

4. This method will NOT remove 100% of the solder and may cause circuit pad lifting on single-sided boards due to the extremely high vacuum which is generated.

5. Proper care of this tool to maintain efficient operation requires that it be disassembled and cleaned thoroughly on a regular basis.

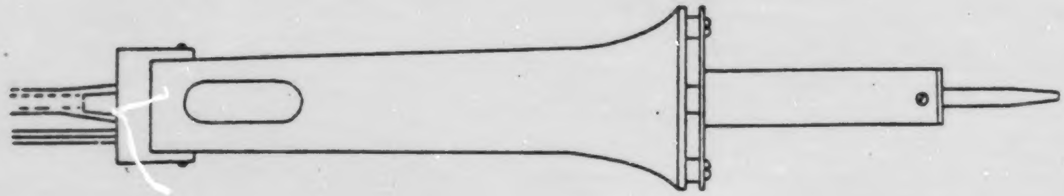
G. The most efficient and versatile of all solder extraction methods is the motorized vacuum method utilizing the "SX 300" solder extractor, which has the following features:

1. In-line extraction path allowing solder to be pulled directly into the solder trap chamber.

2. Positive locking mechanism for chamber end caps allowing the unit to be used for both vacuum and pressure.

3. Long thin heating element allowing access to confined areas.

4. The operator is protected from contact with the hot glass solder trap chamber since it is installed within the plastic handle.



PACE IN-LINE-EXTRACTOR

NOTE: The following procedures or techniques should be utilized with the motorized vacuum extraction method to achieve maximum effectiveness and minimum workpiece degradation.

H. Motorized vacuum extraction techniques.

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1. The extractor tip must be positioned to allow maximum airflow through the soldered connection for best results. In a dead end hole situation, the majority of the solder is removed with the vacuum and the remainder is blown out with pressure. To prevent sweat joints between component leads and circuit conductors, a stirring motion of the lead with the extractor tip MUST be used.

   a. A sweat joint is a paper-thin solder joint formed by the minute amount of solder remaining on the conductor and lead surfaces which cannot be removed by extraction.

   b. To properly prevent sweat joints from forming, the lead must be moved in a stirring motion as soon as the solder has completely melted and before vacuum is applied. The stirring motion must be maintained during the vacuum application and kept up until the airflow has caused the solder to cool and solidify.

NOTE: During the stirring action, the extractor tip MUST NEVER CONTACT ANYTHING EXCEPT THE SOLDER AND THE LEAD ITSELF since contact with circuit conductors will nearly always cause damage.

2. Lead and hole size have several factors affecting solder extraction.

   a. The amount of space between the lead and the sides of the hole will affect the extraction efficiency by varying the airflow through the hole.

   b. The depth of the hole will determine the length of time the heat must be applied for a complete solder melt.

3. Both the inside and outside diameters of extractor tips must be considered when selecting a tip.

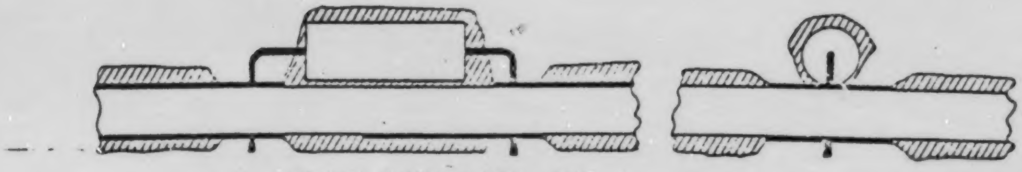
   a. The inside diameter is determined by the component lead diameter, which it must fit over.

   b. The outside diameter is determined by the size and mass of the pad.

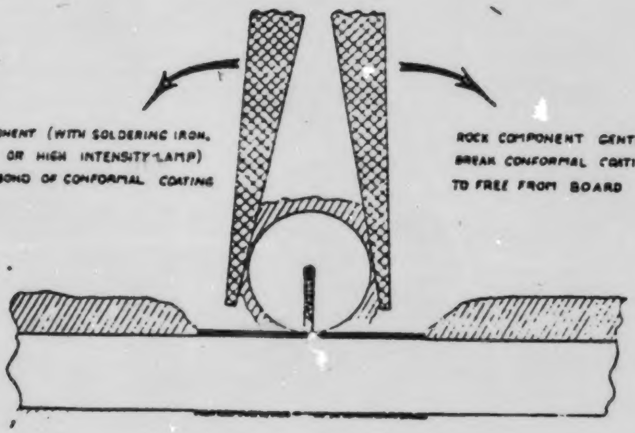
   c. Extractor tips may be modified to fit over various lead terminations, or to fit small, low-mass pads.

      (1) A ball mill can be inserted inside the tip and used with the rotary tool as a turning and holding device.

      (2) A file is used to shape the tip to the desired form as it is turning.

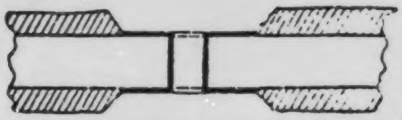


EXTRACT SOLDER TO FREE LEADS



HEAT COMPONENT (WITH SOLDERING IRON, HOT AIR JET OR HIGH INTENSITY LAMP) TO SOFTEN BOND OF CONFORMAL COATING

ROCK COMPONENT GENTLY TO BREAK CONFORMAL COATING BOND TO FREE FROM BOARD



1. CLEAN PAD / HOLE AREA THOROUGHLY! ENSURE REMOVAL OF ALL DEAD SOLDER, DIRT AND CONFORMAL COATING
2. CHECK FOR DAMAGE AND NEEDED REPAIRS
3. RE-TIN PAD/HOLE PRIOR TU INSTALLING NEW COMPONENT

d. The exposed copper on the modified tip should be tinned to prevent oxidation and improve heat transfer.

NOTE: The extractor handpiece (element and tip) will attain a temperature of approximately 1,000 degrees at maximum setting of the variable AC control and MUST be used with EXTREME CAUTION. The temperature MUST be properly adjusted for each particular task to avoid causing overheat damage to the workpiece.

I. Component removal procedures after solder extraction are as follows:

1. Straight-through terminations allow the component to be lifted gently from nonconformal coated boards.

2. The various clinched style terminations may require the breaking of a sweat joint which may be done by gripping the lead with pliers or tweezers and rotating the clinched portion approximately 30 degrees PARALLEL to the board surface.

3. After breaking the sweat joint the lead may be lifted gently to a straight position.

NOTE: Do NOT attempt to lift or straighten the lead until the sweat joint is broken.

4. After the component lead is completely free and straight remove the component from a conformal coated board by

a. Heating the component with a soldering iron tip or by blowing hot air from the solder extractor (preferred method)

NOTE: Use extreme caution not to cause damage to the workpiece with the heat of this operation.

b. After any residual coating is softened by heat, grip the component gently with a pair of tweezers or pliers and free it from the coating by a gently side-to-side rocking motion.

c. At this point the component may be lifted carefully from the board.

J. Evaluating individual workpieces to determine proper techniques for desoldering and removing components.

  1. A careful, thorough physical examination must be made to determine the solder-joint characterisitcs, most effective desoldering technique, and the tools to be used in applying these techniques.

  2. A careful step-by-step analysis of the task as it is to be performed MUST take into consideration possible hidden characteristics.

K. Inspecting completed work for damage to the circuit board or to the remaining components.

  1. Board damage - check for:

    a. Scorching or charring caused by component failure or improper repair techniques.

    b. Measling, which is the appearance of white spots that are small areas of the fiber glass strands which have been exposed by heat, abrasion, or solvent action.

    c. Possible cracks or breaks in the board material.

  2. Conductor damage - check for:

    a. Any missing pads or conductors.

    b. Any nicked or cracked conductors.

    c. Lifted or delaminated pads or conductors.

  3. Component damage - check for:

    a. Cracked, broken, or overheated components.

    b. Deformed or broken component leads.

    c. Poor solder joints and loose or splashed solder which may cause shorts.

L. Safety precautions

  1. Workpiece

    a. Never perform any action on the workpiece which will cause damage or degradation.

b. Handle all workpieces as though extremely fragile.

c. Maintain scrupulous cleanliness at all times.

2. Tool

a. Properly clean all tools and store them in the proper place. Special care is necessary in maintaining the SX-300 Solder Extraction System.

(1) Removing the glass chamber - Use a gentle push-turn motion to release the retaining cap, and carefully withdraw the glass chamber to avoid breakage.

(2) Cleaning the glass chamber - The large bristle brush is used to clean the glass chamber after carefully pushing out the metal baffle and the cotton vapor trap. A light coating of mineral oil after cleaning will aid in future cleaning.

(3) Cleaning the extractor element - The extractor element is cleaned with the small wire brush, after the tip is removed. Cleaning and tip removal must be performed AT LEAST once daily, (or every 8 hours of operation) and the extractor shall be stored with the tip removed.

(4) For periodic and unscheduled maintenance of the SX-300 power and vacuum supply refer to the equipment handbook.

b. Never use excessive force on any tool.

c. Use each tool only in the manner for which it was designed to be used.

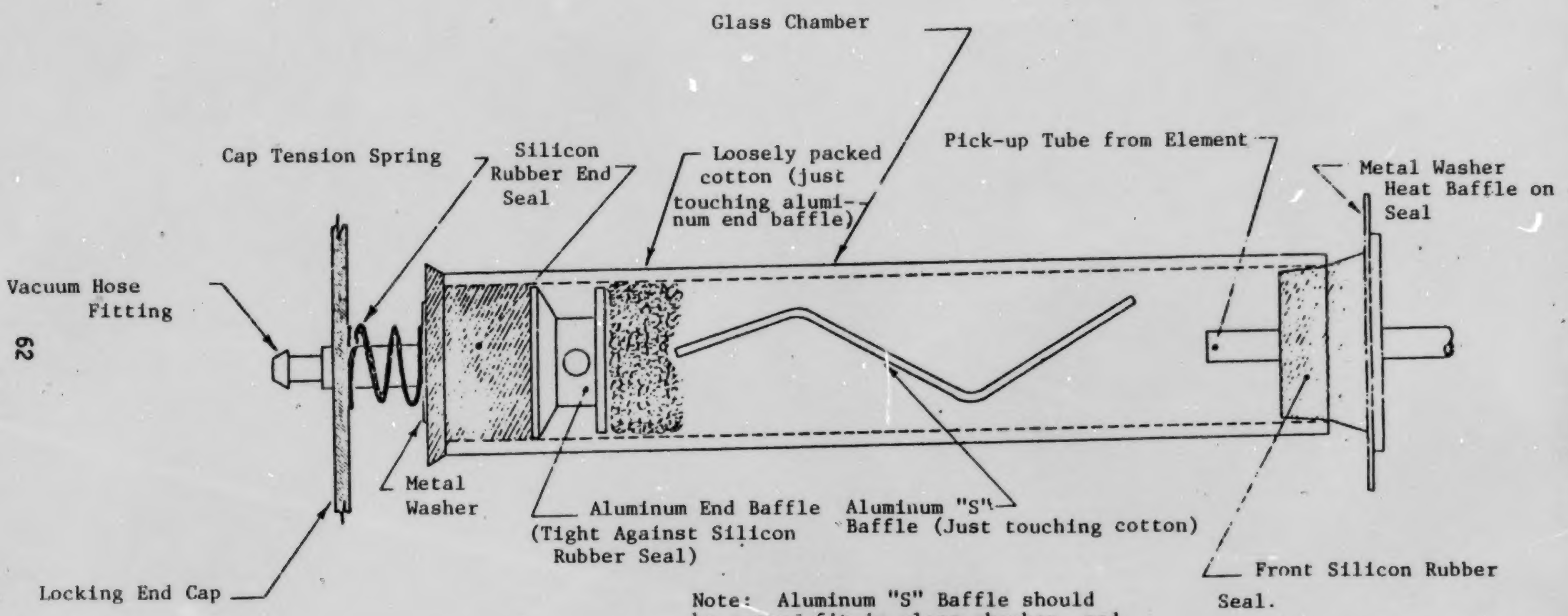
d. Check all electrical cords daily for damage from hot tools, solvents, or abrasion.

3. Personal

a. Beware of burns from hot tools (keep tools in the holders provided).

b. Avoid prolonged skin contact and excessive breathing of chemical fumes.

c. Beware of flammable chemicals and materials.


Glass Chamber
Cap Tension Spring
Silicon Rubber End Seal
Loosely packed cotton (just touching aluminum end baffle)
Pick-up Tube from Element
Metal Washer Heat Baffle on Seal
Vacuum Hose Fitting
Metal Washer
Aluminum End Baffle (Tight Against Silicon Rubber Seal)
Aluminum "S" Baffle (Just touching cotton)
Front Silicon Rubber Seal.
Locking End Cap

Note: Aluminum "S" Baffle should be a snug fit in glass chamber, and it must not touch pick-up tube from element!

If allowed to touch pick-up tube, molten solder will be chilled, solidify and block tube. Reducing or stopping vacuum flow to extractor tip. Work-piece damage will result!

Note: Glass chamber must seat or tap seal, or vacuum will be lost (front seal is mounted inside extractor hand piece)

EXTRACTOR ASS'Y

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1459

ASSIGNMENT SHEET 2-4-1A

TITLE

Repair of Damaged Printed Circuit Boards

OBJECTIVES

When you complete this lesson topic, you will be able to:

2.4.1 IDENTIFY the four categories of damage common to printed circuit boards as identified in MIL-STD-275C and 454D.

2.4.2 DETERMINE the extent of repair required and proper repair techniques to be used on any printed circuit board in accordance with information contained in MIL-STD-275C and 454D.

2.4.3 REPAIR damaged printed circuit board laminates, conductors and eyelets using the proper tools and techniques and to the standards outlined in MIL-STD-275C and 454D.

STUDY ASSIGNMENT

Read and study Notetaking Sheet 2-4-1N of the Student's Guide.

STUDY QUESTIONS

None

NOTETAKING SHEET 2-4-1N

TITLE

Repair of Damaged Circuit Boards

REFERENCES

MIL-STD-454D
MIL-STD-275C

NOTETAKING OUTLINE

A. Types of circuit board damage.

1. Four common categories of damage are:

   a. Cracked boards

   b. Scorched, charred or deeply burned boards.

   c. Broken boards.

   d. Delaminated circuit board layers.

2. Determining the extent of damage.

   a. Cracked boards

      (1) Length and depth of the crack must be determined by physical inspection.

      (2) Disruption to conductors and components caused by the crack must be determined.

      (3) Care must be taken in examining cracked boards not to cause additional damage.

   b. Scorched, charred or deeply burned boards.

      (1) Determine the area of the board affected by the discoloration of the surface, molten or blackened conductors and burned, melted or blackened components.

      (2) Determine the depth of the affected area which may range from a slight surface discoloration to a gaping hole through the circuit board.

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c. Broken boards

(1) Determine if all parts of the board are present.

(2) Determine if circuit conductors or components have been affected by the break.

(3) Determine if the broken pieces may be rejoined RELIABLY or if new pieces must be manufactured.

d. Delaminated circuit board layers.

(1) Determine the area of delamination.

(2) Determine if the circuit conductors or components have been affected by the delamination.

NOTE: This type of damage, unless occurring in a limited area, is beyond the capabilities of field tools and techniques and required manufacture of a new board laminate (possibly using conductors and components off the damaged board).

B. Circuit board repair techniques.

1. Patching

a. Damage which does not extend completely through the board may be repaired by the patching technique.

b. The patching technique consists of the following steps:

(1) If the board is scorched, charred or burned, remove all discolored board material, including any measles, by abrasive methods.

(2) Repairable delaminations which do not extend to the edge of the circuit board should be cut away by abrasive methods until no delaminated material remains.

(3) Do not remove delaminated material if a repairable delamination exists which extends to the edge of the printed circuit board.

(4) After removing all damaged board material, level and/or undercut the edge of the removed area to provide physical holding points for the repair material.

(5) Clean thoroughly with solvent to remove all loose particles.

(6) Mix a compound of epoxy and powdered fiber glass and fill the cutaway area with this compound, being EXTREMELY careful to leave no voids or air bubbles.

(7) Level the surface of the filled-in area being sure that the surface of the fill material is no lower than the original board surface.

(8) In the case of delaminations on the edge of the board, fill the delaminated layers COMPLETELY with the repair mixture and clamp firmly together between two flat surfaces.

(9) Cure the epoxy repair mixture completely as per the manufacturers instructions found on the package.

(10) After cure is completed, smooth the repaired surface to the same level as the original board using abrasive methods.

(11) If necessary, redrill any holes which existed in the damaged area and clean the repair thoroughly.

2. Rebuilding

a. Damage which extends completely through the board, such as cracks, breaks and holes, must be repaired using rebuilding techniques.

b. Cracks are repaired using the following steps:

(1) Remove all chips and fractured material using abrasive methods.

(2) Level and under cut the edges of the removed area to provide NEEDED physical bond strength.

(3) Fasten a smooth surface tightly against one side of the removed area.

(4) Using clamps fasten the board firmly and immovably, keeping any loose pieces in proper alignment and with the uncovered side of the repair area up.

(5) Mix a compound of epoxy and powdered fiber glass and fill the cutaway area with this compound, being extremely careful to leave no voids or air bubbles.

(6) Level the surface of the filled-in area being sure that the surface of the fill material is no lower than the original board surface.

(7) Cure, smooth, redrill and clean as in the patching method.

c. Breaks and holes are repaired in the same manner as cracks unless broken pieces are missing or the hole exceeds 1/2 inch in diameter, in which case the following repair steps are used.

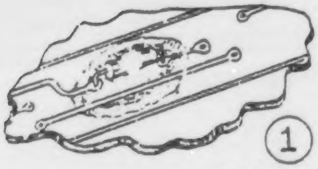
(1) Using the same technique as with crack repair, prepare the damaged edge.

(2) Using a scrap board of the same type and thickness, cut a piece that duplicates as nearly as possible the missing area. Prepare the edges of this cut piece in the same manner as the edges of the hole were done.

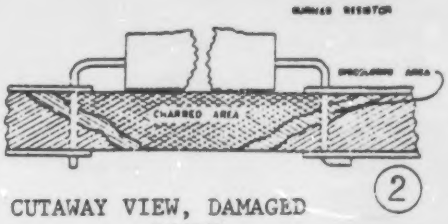
(3) Tightly fasten a smooth surface over one side of the repair area and firmly clamp the board in an immovable position with the uncovered area up.

(4) Position the replacement piece as nearly as possible to duplicate the original board configuration. Firmly clamp the replacement piece in place.

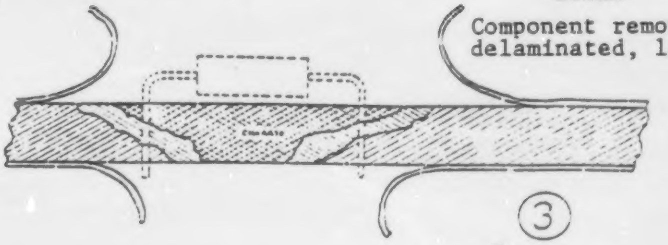
(5) Complete the repair using the same epoxy-fiber glass mixture and repair techniques as in the patching repair method.



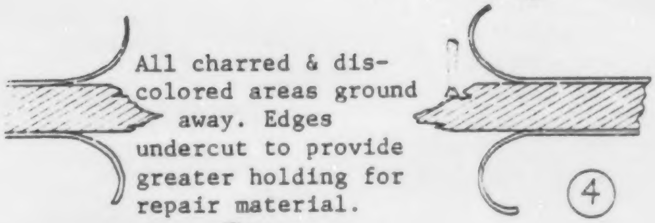
Area of board damaged by failure of component.



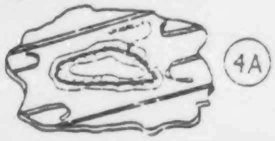
CUTAWAY VIEW, DAMAGED BOARD

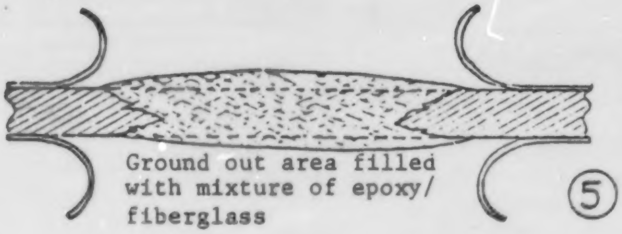


Component removed - Conductors delaminated, laid back out of the way.



All charred & discolored areas ground away. Edges undercut to provide greater holding for repair material.




Ground out area filled with mixture of epoxy/ fiberglass

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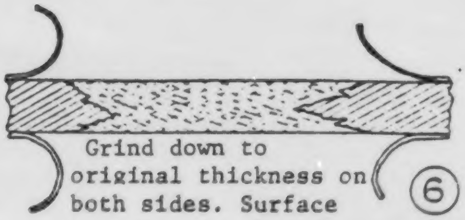
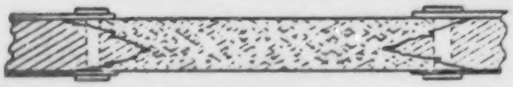

Grind down to original thickness on both sides. Surface must be smooth and even, free from lumps and hollows

⑥


Epoxy runs back in position, cure. Carefully redrill holes and install eyelets. Board is now ready for installation of new component.

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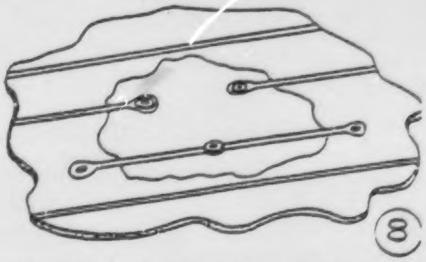
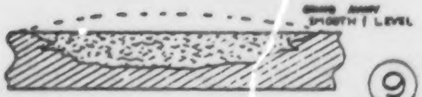
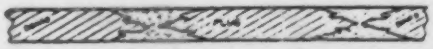

⑧

Completed repair. Runs replaced, eyelets installed, ready for component installation.



⑨

Repair of surface damage is the same. Except only one side of board requires work.


Board repaired using plug of similar board material - ⑩ used for larger repairs. See note also for repairs where heavy components are mounted.

C. Types of printed circuit run and pad damage are:

1. Cracked conductors

   a. Cracks in conductors may be partially or completely through the conductor.

   b. Crack damage which includes nicks and scratches in the conductor must be repaired if it exceeds one-tenth of the cross-sectional area of the conductor.

2. Missing conductors

   a. In this type of damage, pads or conductor runs are completely missing from the board.

   b. Also included in this type of damage are conductors that are present but physically damaged to a point beyond repair.

3. Delaminated conductors

   a. Delaminated conductors are those which are no longer bonded to the board surface.

   b. The delamination may occur at any portion of the conductor.

D. Printed circuit run and pad repair techniques.

1. Crack repair

   a. Cracks in printed circuit conductors are repaired using the following techniques.

      (1) One method of repair is to flow solder across the crack, forming a "solder bridge". This is not a high-reliability repair (since the solder in the break will crack easily) and should be used only when no other technique can be used.

      (2) Another method of repair is to lap solder the crack. This method is somewhat stronger than a solder bridge, but still is not highly reliable as it is also subject to solder cracking.

      (3) A third repair technique is to drill a hole through the board where the crack is (always drill the hole smaller than the width of the run), then install an eyelet in the hole and solder it in place.

      (4) The clinched staple method of crack repair is the most reliable and may be used in nearly all cases. Care must be taken when using this technique not to drill the holes through conductors and components on the other side of the board, and to use insulated wire if the wire crosses other conductors or leads.

2. Conductor and pad replacement

   a. Damaged or missing conductor replacement.

      (1) To replace sections of conductors, cut away the badly damaged portion, if present, and drill a small hole through the remaining conductor at each end of the break. Do not drill the hole through conductors on the opposite side of the board.

      (2) Use a wire jumper to replace the missing conductor. Insulated wire must be used to prevent shorts if the jumper crosses other conductors.

(3) The replaced section is placed on the opposite side of the board to provide maximum physical strength.

   (a) This type of repair is merely an elongated version of the clinched staple.

   (b) The reliability of the repair may be increased even more by installing an eyelet in each of the holes before installing the jumper.

3. Missing pad repair.

   a. Obtain a replacement pad from a scrap circuit board.

   b. Clean the replacement pad and the area where it will be installed.

   c. Epoxy the replacement pad to the board.

   d. Reinforce the pad by installing an eyelet before the epoxy sets and cures.

   e. After the epoxy cures, lap solder the pad to the original run.

   f. For maximum reliability, the conductor edges should be beveled before installation. As an alternate to beveling a matching spacer pad may be positioned on the board and the replacement pad lap soldered to both it and the conductor after epoxying the pads to the board and installing an eyelet through both pads.

4. Conductor bonding

   a. Mix a small amount of epoxy and apply it to the conductor and the conductor path, leaving no uncoated areas.

   b. Clamp the conductor firmly against the board surface until the epoxy has complete cured.

   c. If the lifted area is at the end of a conductor, it may be eyeletted immediately after the epoxy is applied.

E. Techniques for replacing damaged printed circuit eyelets.

1. Selecting

   a. The eyelet must be approximately 1/32 inch longer than the board thickness.

   b. The inside diameter of the eyelet must be just large enough to allow the lead to pass through it freely without binding.

c. The hole must not be drilled at an angle.

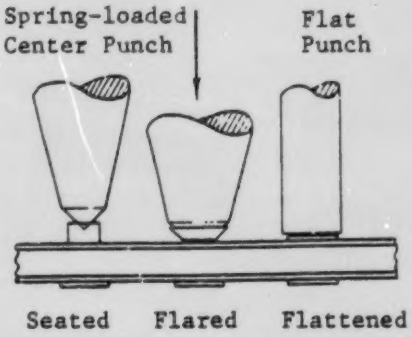
d. When replacing an eyelet where one previously existed, the drill bit should be the same as the original hole and the eyelet should be picked to fit the hole size.

e. When drilling to install an eyelet where none previously existed, be sure to examine both sides of the board and determine that no conductor damage or shorting will be caused by the eyelet installation.

2. Setting

a. The first step in setting an eyelet is to brace the preformed head of the eyelet against a flat, solid surface such as a jewelers anvil.

b. The unformed end of the eyelet is then flared to an approximate 45 degree angle by punching the end with an adjustable spring-loaded automatic center punch.



Hand Setting

c. The punch is adjusted for proper striking force by setting a practice eyelet on a scrap circuit board.

d. The flared end is set flat by tapping a flat pin punch GENTLY against the flared end with a soft faced hammer. A single tap should be sufficient to properly set the eyelet.

3. Soldering.

a. After setting, the eyelet must be soldered to the circuit conductor for highest reliability.

b. If a lead or wire is to be soldered through the eyelet the lead and eyelet should both be soldered in a single operation.

c. Pretinning may be required depending on the eyelet material and/or plating.

F. Evaluating damaged printed circuit boards to determine the extent of repair necessary and the repair techniques to be used.

1. Determining board construction.

a. The following major characteristics must be properly evaluated to determine the overall construction of a circuit board:

(1) Type of circuit baseboard material.

(2) Circuit conductor style.

793

    (3) Component types
    (4) Component mounting style
    (5) Type of lead termination
    (6) Type of interfacial connection
    (7) Solder-joint type
    (8) Type of conformal coating

2. Determining the type and extent of damage.

    a. The type of damage is determined by the portions of the assembly which are affected. The most common types are:

        (1) Component damage
        (2) Coating damage
        (3) Conductor damage
        (4) Baseboard damage

    b. The extent of damage is determined by the nature of the damage to each individual portion of the assembly.

        (1) .Coatings may be peeled, burned, charred or dissolved.
        (2) Conductors may be cracked, broken, delaminated or missing.
        (3) Baseboards may be cracked, broken, delaminated, charred, burned or have pieces missing.

3. To evaluate the feasiblity of repair, ask:

    a. Is reliable repair possible with the available tools and techniques?

    b. Can the board be salvaged at the expense of destroyed components?

    c. Can the components be salvaged when the board is not repairable?

    d. Is reliable repair possible at a higher maintenance level (micro-miniature repair specialist)?

1470

4. Choosing the appropriate repair techniques.
    a. After completely evaluating the repair task to be performed, establish a step-by-step repair procedure.
    b. Choose the available tools and techniques which will most reliably complete the steps of the repair procedure.

G. Inspecting repaired printed circuit baords for completeness and quality of repair.

1. Condition of the laminate.
    a. Inspect the laminate material for any unrepaired damage.
    b. Inspect the laminate repairs for quality and reliability.
2. Condition of the conductors
    a. Inspect the conductors for any unrepaired damage.
    b. Inspect the conductors repaired for quality and reliability.
3. Condition of the eyelets
    a. Inspect the eyelets for any unrepaired damage.
    b. Inspect eyelet repairs for quality and reliability.

H. Safety precautions

1. Workpiece
    a. Never perform any action of the workpiece that will cause damage or degradation.
    b. Handle all workpieces as though extremely fragile.
2. Tool
    a. Never use excessive force on any tool.
    b. Use each tool only in the manner it was designed to be used in.
3. Personal
    a. Use eye protection when using power tools and when there is a chance of splashing chemicals.
    b. Do not breathe dust particles from cutting and grinding operations.
    c. Beware of burns from hot tools

795

ASSIGNMENT SHEET 3-1-1A

TITLE

Soldering to Turret Terminals

OBJECTIVES

When you complete this lesson topic, you will be able to:

3.1.1 PREPARE turret terminals for soldering by cleaning and tinning following procedures and to the standards outlined in MIL-S-45743C.

3.1.2 PREPARE wires for soldering by stripping, tinning and bending following the procedures and to the standards outlined in MIL-S-45743C.

3.1.3 CONNECT prepared wires to turret terminals using the proper tools and soldering techniques following the procedures to the standards outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4(3A).

STUDY ASSIGNMENT

Read and study Notetaking Sheet 3-1-1N of the Student's Guide.

STUDY QUESTIONS

None

NOTETAKING SHEET 3-1-1N

TITLE

Hand Soldering Turret Terminals

REFERENCES

MIL-S-45743C
MIL-STD-454D
NHB 5300.4 (3A)

NOTETAKING OUTLINE

A. Types, sizes and usage of turret terminals.

1. Common types
    - a. Those designed to protrude from one side of the mounting surface only.
        - (1) Single section
        - (2) Multiple section
    - b. Those designed to protrude from both sides of the mounting surface (feed-through types).
        - (1) Single section
        - (2) Multiple sections
        - (3) Combinations
2. Common sizes
    - a. Turret terminals are used in many sizes.
    - b. The terminal size and conductor size should match.
    - c. The procedure of placing a large component or conductor on a small terminal creates undesirable stress [illegible] the terminal which may lead to unreliability of the [illegible]bly.
3. Uses - Turrent terminals are used for the following:
    - a. For providing interfacial connections on printed circuit boards.
    - b. As terminal points for point-to-point wiring.
    - c. For mounting components.
    - d. As tie points for interconnecting wiring.

B. Preparing turret terminals for soldering.

1. Cleaning

a. Terminals must be cleaned prior to attaching leads or conductors. Cleaning may be done by:

(1) Adding, then removing new solder from the terminal surface, thus removing oxides.

(2) On new, relatively clean terminals, the use of solvent is often sufficient. If not, then the above method should be used.

(3) Old, used, very dirty, or highly oxidized terminals may rewire repeated solder coating/removal steps and/or abrasive techniques to properly prepare them for soldering.

b. If the terminals must be handled after cleaning operations, a recleaning with solvent is necessary to remove the oils and salts deposited from contact with the skin.

2. Tinning terminals

a. Terminals must be tinned prior to soldering. This enhances the flow of solder and aids in the formation of a reliable intermetallic bond.

b. The solder coating/removal steps involved in the cleaning process provide a good tinned surface.

c. For tinning a new terminal, the application of flux and fresh solder with the proper heating to cause the solder to wet thoroughly is required.

C. Preparing wire for soldering to turret terminals.

1. Tools used

a. Mechanical and/or thermal wire strippers.

b. Soldering iron.

c. Antiwicking tools (tweezers, "Little Joes", etc.).

d. Vise

e. Round nose pliers

f. Nylon rod/orangewood stick.

g. Flush-cutting pliers

h. Soldering iron holder.

1474

2. Insulation removal

   a. The wire is stripped CAREFULLY, using either an approved style of mechanical wire stripper or the thermal strippers (chemical stripper for varnish).

   b. Only mechanical strippers of the nonadjustable, factory set type should be used when thermal strippers are not available. Other types such as the old "Miller" strippers and the combination stripper, crimper and boltcutter are NOT approved.

   c. The nonadjustable, factory set strippers have precision blades to provide reliable stripping without damage when used with care.

   d. These strippers should be inspected frequently to ensure that the blades are sharp and have not become misaligned.

   e. Mechanical strippers should not be used on wire sizes AWG-22 or smaller. The mechanical advantage of the stripper is such that the smaller sizes mentioned may be stretched by the pulling action of the stripper as the insulation is removed.

   f. Any damage to the wire caused by stripping (cuts, scrapes, nicks, or "birdcaging") is grounds for rejection. The damaged area shall be removed and the wire restripped.

   g. Thermal strippers, utilizing a controlled melting action, should be used whenever possible as the chance for wire damage is minimized.

   h. The wire is inserted into the jaws of the thermal strippers. Some models have an adjustable stop to provide a repetitive strip length, and some have an adjustment for depth of jaw cut.

   i. In operation, the jaws are closed GENTLY on the wire and power is applied. The wire is then turned approximately 90 degrees when the melting action becomes visually apparent.

   j. When the jaws have melted through the insulation creating a cut completely around the circumference of the wire, the jaws are opened and the wire removed. The action desired is to MELT through the insulation, NOT to burn through. Burning will damage the insulation and cause rejection of the wire.

k. Remove the insulation with your fingers. The insulation must be allowed to turn and follow the lay of the wire strands during this operation to prevent birdcaging of the wire. DO NOT change the rate of twist of the wire in the stripping process. The wire strands should not be disturbed.

l. Chemical stripper is used to remove varnish type insulation from motor/magnet wire.

   (1) Dip the wire in the chemical

   (2) Allow three minutes for softening

   (3) Use a disposible tissue (kimwipe) to clean the softened varnish off of the wire.

   (4) Neutralize the exposed wire with water or a solvent to prevent the chemical from damaging the remaining insulation.

3. Tinning the wire

   a. Tinning of the wire is required to prevent damage in the bending operation and to enhance the flow of solder during the soldering operation.

   b. The use of antiwicking tweezers to prevent solder wicking up under the insulation due to capillary action is recommended.

      (1) The operation is performed by bringing a clean dry soldering iron in behind the wire, one third to one half the distance down from the antiwicking tool.

      (2) Solder is applied at the junction of the iron and the wire, and allowed to soak into the wire.

      (3) The iron and solder are then moved up the wire toward the antiwicking tool.

      (4) When the iron and solder reach the antiwicking tool, hesitate momentarily and continue to flow in solder, then work back down and off the end of the wire carrying any oxides removed by the flux off the wire.

c. Alternate method of tinning wire.

(1) Melt fresh solder on the clean dry tip.

(2) Lay the wire into the molten solder while adding solder to the top of the wire.

(3) When the solder is seen to soak into the wire, move the wire in the same manner as in the previous method of tinning, hesitating next to the antiwicking tool, then back the wire through the solder until the cut end is reached and then off the iron.

d. For best results in tinning, the iron must be at full line voltage. A flat faced tip should be used.

4. Bending

a. Any method may be used for bending that does not damage the wire in any way.

(1) Round nose pliers

(2) Nylon rod/orangewood stick

(3) Dummy terminal

D. Turret terminal solder connection specifications.

1. Wire wrap

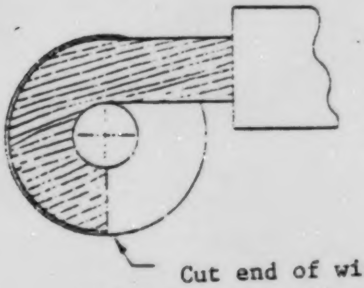
a. In all cases for turret terminals, the minimum wrap around the terminal shall be 180 degrees (one half turn).

b. Maximum amount of wrap depends on the wire size.

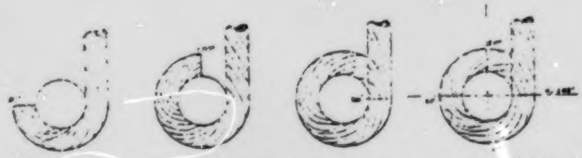
(1) AWG-26 and smaller may be wrapped up to 360 degrees (one full turn).

(2) AWG-24 and larger may be wrapped up to 270 degrees (three fourths of a turn).

c. The preferred wire wrap is 180 degrees for all sizes of wire.

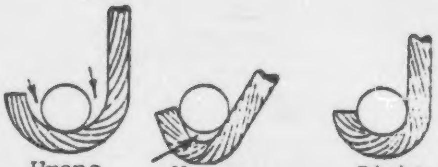


Cut end of wire should be even with center of post, bend radius same as radius of post (Snug fit)



TURRET TERMINAL WIRE WRAP

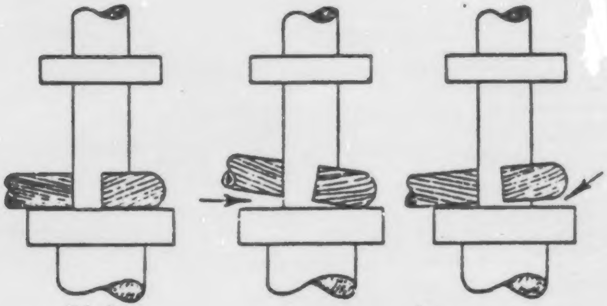
d. The size of the bend made shall be such that the bend will fit firmly against the terminal post throughout the entire wrap, and cover a minimum of 180 degrees.


Wrong
Wrong
Right

BEND RADIUS

2. Wire position

a. Proper position of the wire on the terminal requires that it be set firmly against the post portion of the terminal and that it be set flat on the pad area as viewed both from the front and side.


Right
Wrong
Wrong

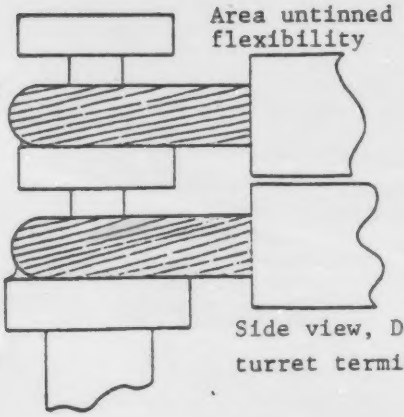
b. Wire holding devices may be used to hold the wire in position and to prevent motion while soldering.

c. Wire positioning requirements are the same for two or more wires as they are for single wire connections with the following additional requirements:

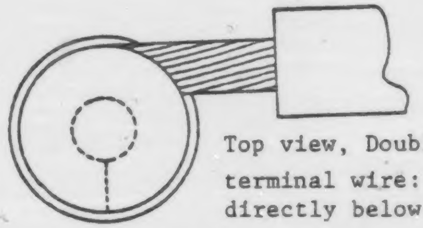
(1) All wires are wrapped in the same direction.

(2) All wires are trimmed to the same lengths.

(3) Wires are positioned directly one above the other.


Area untinned for flexibility
Good fillet formed between post and wire

Side view, Double entry turret terminal



Top view, Double entry turret terminal wire: Bottom wire directly below top wires.

d. In field operations any method that will hold the wire may be used, such as the use of rubber bands, clips, etc.

3. Area to be soldered.

a. The area to be soldered consists of the pad portion of the terminal, the post portion of the terminal and the area of the wire in contact with the terminal.

b. Where cutting the bent wire leaves copper exposed, the soldering operation must ensure that no copper remains exposed.

4. Solder quantity

a. Solder quantity shall be such that all angles formed by the junction of the wire and the terminal will be filled with solder to form a fillet.

b. Overall flow of solder shall present an appearance of concave fillets extending approximately one half the way up the wire.

c. The contour of the wire strands shall be visible.

d. There shall be no convex appearance to the solder flow on the finished terminal.

E. Tools used to make turret terminal solder connections.

1. Handtools

a. Vise

b. Antiwicking devices

c. Wire securing devices

2. Power tools

a. Soldering iron

b. Variac

F. Techniques for making high quality turret terminal solder connections.

1. Application fo flux.

a. Flux cored solder normally supplies all necessary flux for proper wetting of solder.

b. External flux may be used; however, the possibility of causing the solder to wick under the insulation is high.

2. Proper heat

   a. Proper heating is required to bring the terminal and wire mass RAPIDLY to the melting temperature of solder.

   b. Proper heating is accomplished by using the appropriate size tip and the appropriate wattage element for the size of mass involved.

   c. A solder bridge accomplishes rapid transfer of heat from the iron tip to the connection.

3. Application of solder

   a. For proper application of solder, bring a clean, dry iron into contact with BOTH the terminal and the lead.

   b. A heat bridge should be established between the iron and the lead with clean solder.

   c. At this time, place the solder at the end of the wire to tin the exposed copper, and also form the fillet between the start of the wire bend and the terminal where the wire enters the terminal.

   d. These fillets are formed by wiping the solder across the end of the wire and continuing across the pad portion of the terminal and into the angle formed by the incoming wire and the post.

   e. When the proper amount of solder has been applied, remove the solder and the iron at the same time. This will prevent overheating the solder and result in a smooth, gleaming finish.

4. Cleaning after soldering.

   a. After the solder connection has cooled and the solder has solidified, the connection must be thoroughly cleaned with an approved solvent to remove all traces of flux and/or dirt.

G. Inspecting completed turret terminal solder connnections for quality and reliability.

1. Standards of acceptance

   a. The insulation gap shall be no greater than a distance equal to two times the overall diameter of the wire, including the insulation, measured from the insulation to the edge of the terminal where the wire first makes contact.

   b. The preferred insulation clearance for turret terminals is one overall wire diameter.

c. The wire shall be confined to the guide slots.

d. The wire shall be flat on the pad portion of the terminal.

e. The bend of the wire shall fit snugly against the post.

f. The solder shall have a smooth gleaming finish free from holes, pits and stress lines.

g. The solder shall show no evidence of dewetting from either the terminal or the lead.

h. The contour of the wire strands shall be visible and the solder flow shall present concave fillets.

i. The insulation shall show no signs of overheating such as swelling or discoloration; nor shall it be imbedded in the solder joint.

j. There shall be no wicking of the solder under the insulation. This provides the required flexibility at the connection to prevent vibration and stresses from causing the wire to break at this point.

k. There shall be no spillage of solder over the sides of the terminal (a thin wetted area is acceptable).

l. Inspection of the terminal for quality involves all of the standards of acceptance.

2. Reasons for rejection.

a. Many reasons exist for rejection of a turret terminal connection:

(1) Broken wire strands.

(2) Discolored insulation.

(3) Wire not properly positioned on the terminal.

(4) Overheated solder.

(5) Disturbed solder.

(6) Wicking.

(7) Scraped spots on the terminal.

(8) Pits in the solder.

805

(9) Dewetting.

(10) Nicked strands.

H. Safety precautions.

1. Workpiece
   - a. Never perform any action on the workpiece which will cause damage or degradation.
   - b. Maintain scrupulous cleanliness at all times.
2. Tool
   - a. Clean and store all tools properly.
   - b. Never use excessive force on any tool.
   - c. Use each tool only in the manner for which it was designed to be used.
3. Personal
   - a. Beware of burns from hot tools.
   - b. When using chemicals beware of skin, eye and internal contact, and avoid excessive inhalation of fumes.
   - c. Teflon releases toxic fumes at 400 degrees F. Be especially careful when thermally stripping wire as the element of the stripper exceeds 400 degrees and will cause fuming of Teflon insulation.
   - d. Use eye protection when there is a danger of splashing chemicals.
   - e. Avoid any possibility of igniting flammable chemicals or materials.

1482

INFORMATION SHEET 3-1-1I

TITLE

Electrical Wire Splicing

INTRODUCTION

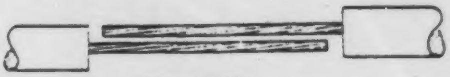
Electronics personnel have long needed training and standardized methods for making reliable wire splices. This has been particularly true in the field of miniature/micro-miniature repair where many wires that are highly susceptable to damage are used. The information section below explains four reliable methods of splicing wires in electronic equipment.

INFORMATION

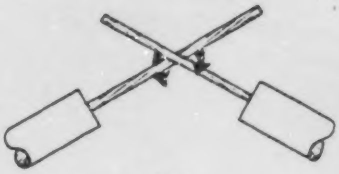
Wire preparation is as important in splicing as it is in any other soldering operation. Preparation consists of stripping the insulation off of the wire, and tinning the strands to prevent damage during the making of the mechanical portion of the splice. Stripping and tinning techniques for splices are the same as those for any other use of stranded wire, except that one type of splice, the mesh splice, requires that the wire NOT be tinned.

The mechanical connection is very important in providing strength in a splice.

1. The wrap splice is mechanically prepared by laying two tinned wires across each other in an "X" pattern and wrapping them around each other two or three times with a twisting motion of the fingers. To give proper strength and reliability both wires must twist (not one straight wire with the other wrapped around it). The twisted portion should be tight, with the cut end of the wire flush cut and not sticking out from the splice.

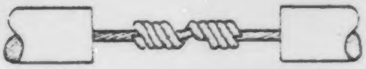


STRIP AND TIN

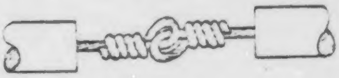


WRAP

2. The hook splice forms the strongest mechanical connection, but it also makes the largest diameter splice, which is often undesirable. Also, this type of splice will require a long section of tinned wire. The splice is formed by making a "J" bend in each of the two tinned wire ends and linking the hooks together, with each wire then wrapped back around itself. The cut end of the wire must be flush cut, and not sticking out away from the rest of the splice.

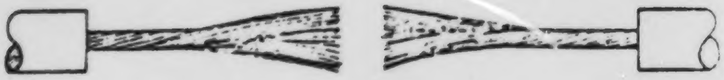


WRAP SPLICE

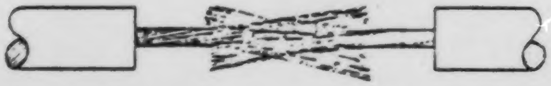


HOOK SPLICE

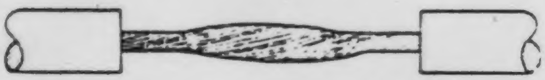
3. The mesh splice has the smallest diameter and is the most flexible splice, but it also provides the least mechanical strength. This is the type of splice that doesn't use tinned wires, which is often an advantage. To form the mechanical connection, first fan the wire strands of both wires out into a cone shape. The wires are then pushed straight into each other so that the strands interlace evenly, without bunching. Finally, the wires are gripped gently with the fingers and twisted in such a manner as to approximate the original wire lay. This type of splice CANNOT be used for double twisted wires. The reason for this is that the double twisted wire has an inner core of strands that are wrapped opposite of the lay of the outer layer of strands. The inner core of strands will normally not fan out into the cone shape needed for the mesh splice.



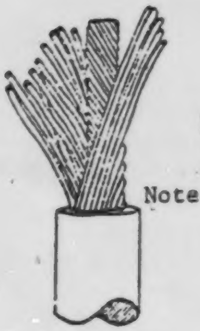
Strip and Spread Ends



Work Ends Together Evenly



Re-twist
Work Ends in Evenly, Smoothly



Double Twist Wire
(High Strength, Flexible)

Note: Cannot be used for "Mesh" Splices

The solder connection is also important in making splices. The specificiations for the three previous splices are the same as those for soldering any wire. The splice must have smooth concave fillets formed at all areas of contact between the wires. The individual strands must be clearly visible through the solder, with NO wicking or heat damage to the insulation.

A relatively new device for making splices is the solder-filled shrinkable splice. These splices consist of a piece of shrinkable tubing with two pre-formed solder rings inside. To use this type of splice, insert two properly stripped and tinned wires into the splice from opposite ends so that the ends of the wires are beside each other. The splice is then shrunk by applying hot air from a heat gun (or the solder extractor in the hot air jet mode). The hot air will cause the solder rings to melt and make the soldered splice while simultaneously shrinking the sleeve to re-insulate the spliced area. This method is quick and reliable, but there is no mechanical connection between the wires and the splice can be pulled apart if subjected to stress.

The use of some type of insulation is mandatory if the splicing of a wire leaves an uninsulated area. Heat shrinkable tubing is the best method of insulating this area. The size of tubing used should be such that it will firmly seal over the original insulation when fully contracted, but not so tight that it will present a danger of splitting when the wire is flexed. Remember to always place the sleeving onto the wire before making the solder connection. Also, the tubing should never be positioned over the splice area until the solder connection has been thoroughly cleaned and inspected. The only reliable method of shrinking tubing is with the use of hot air since other methods (such as a soldering iron tip or open flame) are very likely to cause damage. A heat gun is satisfactory for most average size connections, but in micro-miniature repair the most reliable tool has been found to be the solder extractor used in the hot air jet mode, becuase the heat can be localized to a very minute area. When shrinking tubing, take care not to concentrate too much heat in one spot, by not keeping the source moving the whole time heat is being applied. Too much heat is worse than not enough, as it will cause the tubing to lose some of its insulating properties.

As for any other solder connection, the soldered splice must be inspected. Check that all specificiations and standards of soldering have been met, including solder finish, wetting, quantity, no defects, and no wicking or insulation damage. After installing shrinkable tubing, inspect it to insure it is properly installed, and that there are no damages to the tubing. For solder filled shrinkable splices check that the solder rings have completely melted, the insulation has shrunk completely, and that there is no wicking of the wires.

SUMMARY

The wrap splice is reliable and relatively easy to make, as it requires that the wires only be wrapped around each other. The hook splice is mechanically stronger, but is more difficult to make since it has the wires wrapping back on themselves. The mesh splice is the easiest to make, but is the weakest of the splices, and should not be used where there is stress involved. Solder filled shrinkable splices are easy to make if you have a hot air source, but again, there is no mechanical connection and this type of splice may pull apart if subjected to a pulling stress.

ASSIGNMENT SHEET 3-2-1A

TITLE

Soldering to Hook and Pierced Tab Terminals

OBJECTIVES

When you complete this lesson topic, you will be able to:

3.2.1 PREPARE hook and pierced tab terminals for soldering by cleaning and tinning following procedures and to the standards outlined in MIL-S-45743C.

3.2.2 PREPARE wires for soldering by stripping, tinning and bending following the procedures and to the standards outlined in MIL-S-4743C.

3.2.3 CONNECT prepared wires to hook and pierced tab terminals using the proper tools and soldering techniques following the procedures and to the standards outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4(3A).

STUDY ASSIGNMENT

Read and study Notetaking Sheet 3-2-1N of the Student's Guide.

STUDY QUESTIONS

None

NOTETAKING SHEET 3-2-1N

TITLE

Hand Soldering Hook and Pierced Tab Terminals

REFERENCES

MIL-S-45743C
MIL-STD-454D
NHB 5300.4 (3A)

NOTETAKING OUTLINE

A. Types, sizes, and usage of hook and tab terminals.

   1. Common types

      a. Hook (question mark style)

      b. Hook ("J" style)

      c. Tab (pierced tab eyelet)

   2. Common sizes

      a. Many sizes are used depending on the current flow requirements of the device.

      b. Terminal size and wire size should correspond.

   3. Uses

      a. Hook and tab terminals are used to provide connection points on sealed devices and terminal boards.

      b. Tab terminals are usually connection points on the rear of edge connector receptical pins.

      c. When this type of terminal is used, the connections are normally made in an end-on manner.

B. Preparing hook and tab terminals for soldering.

   1. Terminals must be cleaned prior to attaching leads. Use the same procedures as with turret terminals.

   2. Terminals should always be tinned prior to soldering.

C. Preparing wire for soldering to hook and tab terminals.

1. Stripping the wire requires the same techniques and procedures as used with turret terminals.

2. Tinning the wire requires the same techniques and procedures as with turret terminals.

3. Bending

   a. Any method may be used for bending the wire that does not damage the wire in any manner.

   b. Care must be taken not to crush, overstress, or birdcage the wire during the bending operation.

D. Hook and tab terminal solder connection specifications.

1. Wire wrap

   a. In all cases, for hook and tab terminals, the minimum wrap around the terminal shall be 90 degrees (1/4 turn).

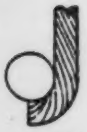
   b. The maximum wrap shall be no more than 270 degrees (3/4 turn).

   c. For hook type terminals the recommended wrap is 120 degrees.

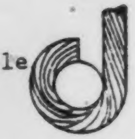
   d. The cut for 120 degrees is not straight across the wire but cut on an angle to form a flush surface with the terminal when installed.

   e. For tab type terminals the recommended wire wrap is 180 degrees. The wire should be flushcut, after bending to 180 degrees.

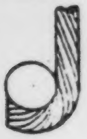
Minimum Acceptable

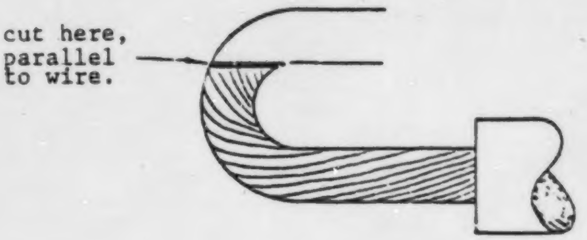


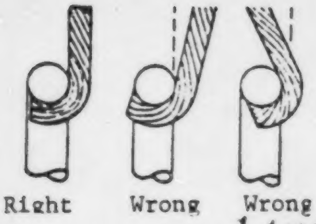
Maximum Acceptable

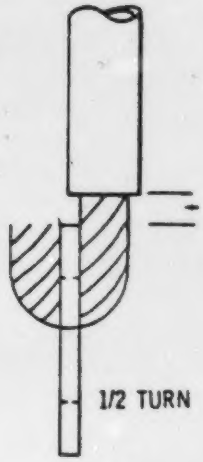


Hook Preferred









2. Wire position

a. Proper position of the wire on hook terminals requires that it be firmly in contact with the terminal; and that the wire entry be vertical to the terminal mounting surface.

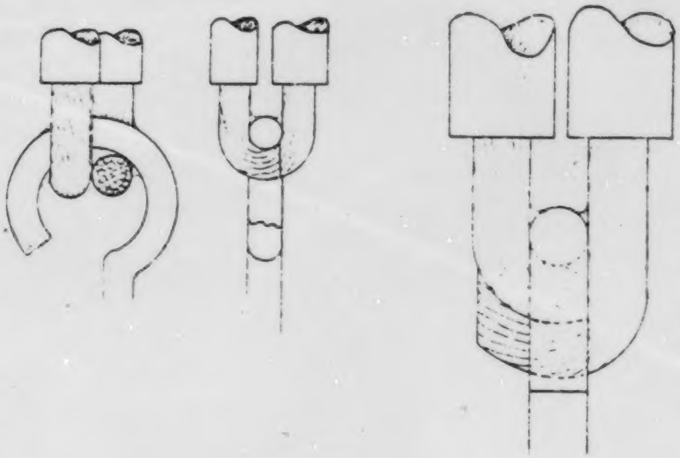
b. Wire position requirements for double or multiple wires on hook terminals are the same as for single wire connections, with the following additional requirements.

(1) The wires wrap around the terminal in alternating directions. This equalizes stresses and protects the glass seal at the base of the terminal from damage.

(2) All wires approach the terminal from the same direction (angle).

(3) The wires normally attach side-by-side on the terminal. If the terminal size, wire size, or number of wires dictate, a piggyback (one wire directly on top of another) mounting style is permissable but care must be taken to adjust the diameter of wire bends accordingly.

c. Wire position requirements for tab type terminals are the same as those for hook terminals with the exception that tab terminal wire entry need not be vertical to the terminal mounting surface.



Do not fill space between wires with solder - use just enough to form good, concave fillets.

3. Area to be soldered.

a. The area to be soldered consists of the portion of the terminal and wire that are in contact with teach other.

b. Smooth fillets must be formed between the wire and terminal at all areas of contact.

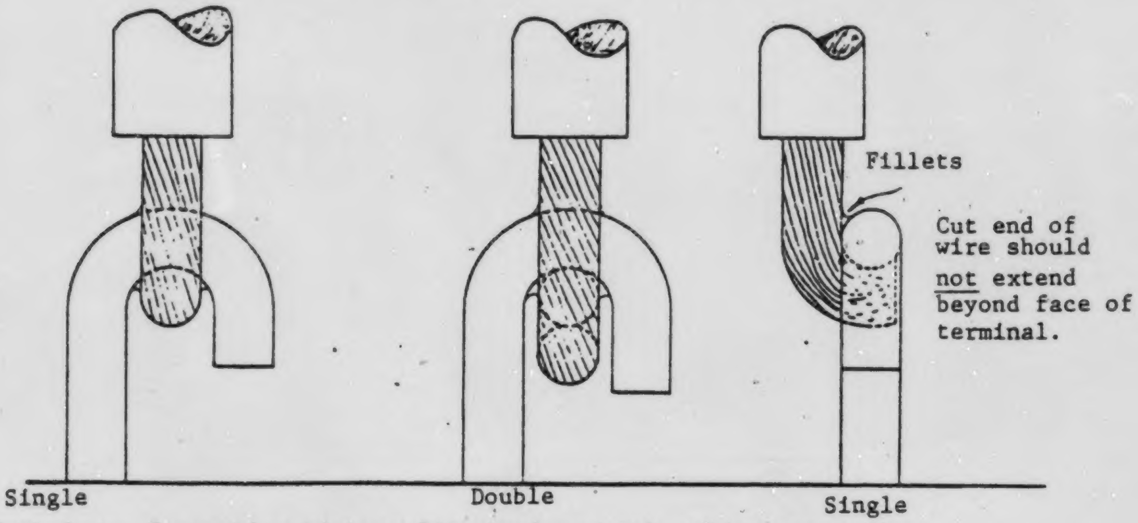
c. There must be no copper exposed on the cut end of the wire.

4. Solder quantity

a. Solder fillets must be formed at all points of contact between the wire and terminal, and all fillets must be concave.

b. There must be no excessive solder flow to other areas of the terminal.

c. Solder quantity must be such that the contours of the wire and the individual strands are clearly visible.



Cut end of wire should not extend beyond face of terminal.

E. Techniques for making high quality hook and tab solder connections.

1. Application of flux.

a. Flux contained within the solder is normally sufficient for soldering a properly cleaned and prepared connection.

b. External flux may be used if desired; however, its use greatly increases chances of solder wicking up under the insulation.

2. Proper heat

   a. The proper heating source is determined by choosing a tip size and element wattage appropriate to the mass being soldered. Use the variable power control to set the tip temperature at the desired level.

   b. Proper heat flow is established by using a clean, dry iron and forming a heat bridge.

3. Application of solder

   a. For proper application of solder, bring a clean, dry iron into contact with the terminal and the wire.

   b. Form a heat bridge at the junction of the iron and the terminal.

   c. Form the solder fillets.

      (1) First, tin the cut end of the wire thoroughly.

      (2) Flow in sufficient solder to form fillets. (NOTE: A very small amount of solder is required to complete this type connection.)

      (3) Remove the iron and the solder at the SAME time.

      (4) Clean after soldering with an approved solvent.

F. Inspecting completed hook and tab terminal solder connections for quality and reliability.

1. Standards of acceptance

   a. Check the following specifications:

      (1) Insulation clearance.

      (2) Wire wrap.

      (3) Wire entry angle.

      (4) Solder, smooth and gleaming with no pits.

      (5) Concave solder fillets in the proper places.

      (6) Bare wire outside of the solder connection remains flexible.

      (7) No bare copper showing.

      (8) Wire and strand contours visible.

b. Multiple wire connections are inspected for all points given for single wire connections plus:

   (1) Alternating direction of wire wraps on hook terminals.

   (2) Wires entering from the same angle and parallel to each other.

c. Reasons for rejection

   (1) Wire damage in any manner.

   (2) Solder wicking up the wire and under the insulation.

   (3) Improper solder quantity.

   (4) Poor wetting action.

   (5) Improper wire positioning and wrap.

   (6) Any copper showing.

G. Safety precautions

1. Workpiece

   a. Never perform any action on the workpiece which will cause damage or degradation.

   b. Keep scrupulously clean at all times.

2. Tool

   a. Clean and store all tools properly.

   b. Never use excessive force on any tool.

   c. Use each tool only in the manner it was designed to be used.

3. Personal

   a. Beware of burns from hot tools.

   b. When using checmicals beware of skin, eye, and internal contact, and avoid excessive inhalation of fumes.

   c. Beware of the poisonous fumes from Teflon during the stripping and soldering operations.

   d. Avoid any possibility of igniting flammable chemicals or materials.

ASSIGNMENT SHEET 3-3-1A

TITLE

Soldering to Bifurcated Terminals

OBJECTIVES

When you complete this lesson topic, you will be able to:

3.3.1 PREPARE bifurcated terminals for soldering by cleaning and tinning following procedures and to the standards outlined in MIL-S-45743C.

3.3.2 PREPARE wires for soldering by stripping, tinning and bending following the procedures and to the standards outlined in MIL-S-47543C.

3.3.3 CONNECT prepared wires to bifurcated terminals using the propertools and soldering techniques following the procedures and to the standards outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4(3A).

STUDY ASSIGNMENT

Read and study Notetaking Sheet 3-3-1N of the Student's Guide

STUDY QUESTIONS

None

NOTETAKING SHEET 3-3-1N

TITLE

Hand Soldering Bifurcated Terminals

REFERENCES

MIL-S-45743C
MIL-STD-454D
NHB 5300.4 (3A)

NOTETAKING OUTLINE

A. Types, sizes and usage of bifurcated terminals.

   1. Common types - there are a variety of terminals of the bifurcated type, since nearly any terminal which has a split or a fork in it is called a bifurcated terminal.

   2. Common sizes

      a. Many sizes are used depending on the current-flow requirements of the assembly in which used.

      b. The terminal size and wire size should correspond.

   3. Uses

      a. In most cases bifurcated terminals are used to solder many wires to a single point.

      b. They are also used in applications exposed to high stress and current flow.

B. Preparing bifurcated terminals for soldering.

   1. Cleaning

      a. Terminals must be cleaned prior to attaching leads or conductors.

      b. The cleaning process used in turret terminal cleaning is also used for bifurcated terminals.

   2. Tinning

      a. Terminals should always be tinned prior to soldering.

      b. The tinning process enhances solder flow on the connection and cleans oxides from the terminal.

C. Preparing wire for soldering to bifurcated terminals.

1. Stripping - use the same techniques and procedures as for turret terminals.

2. Tinning

    a. Use the same techniques and procedures for turret terminals.

    b. Good tinning technique is constant when preparing wire for any type solder connection.

3. Bending

    a. Any method may be used for bending wire that does not damage the wire in any way.

    b. Care must be taken not to crush, overstress, or birdcage the wire during the bending operation.

D. Bifurcated terminal solder connection specifications.

1. Wire wrap - there are three different wire wrap specifications to be considered in the bifurcated terminal connections.

    a. The wire wrap for side entry connections shall be exactly 90 degrees, and the cut end shall be flush with the edge of the terminal base.

    b. Bottom entry wire wrap

        (1) The only practical method of bending the wire for a bottom entry connection is to use the terminal as a bending form, since a bent wire cannot be inserted through the bottom of the terminal.

        (2) The bend for this type of connection must be exactly 90 degrees; however, it is not necessary to make the corner of the bend as sharp as for a side entry.

        (3) The wire for the bottom entry connection is cut flush with the side of the terminal base.

    c. Top entry connection

        (1) The wire in a top entry connection is not wrapped but, if smaller than the space between the terminal ears, is pressed in with a filler wire of the correct size to provide a snug fit between the ears.

(2) The bottom end of the filler wire must be even with the surface of the base, and the top must be cut flush with the top edge of the terminal ears.

(3) Great care must be used when cutting the filler wire not to cause damage to the wire being brought into the terminal.

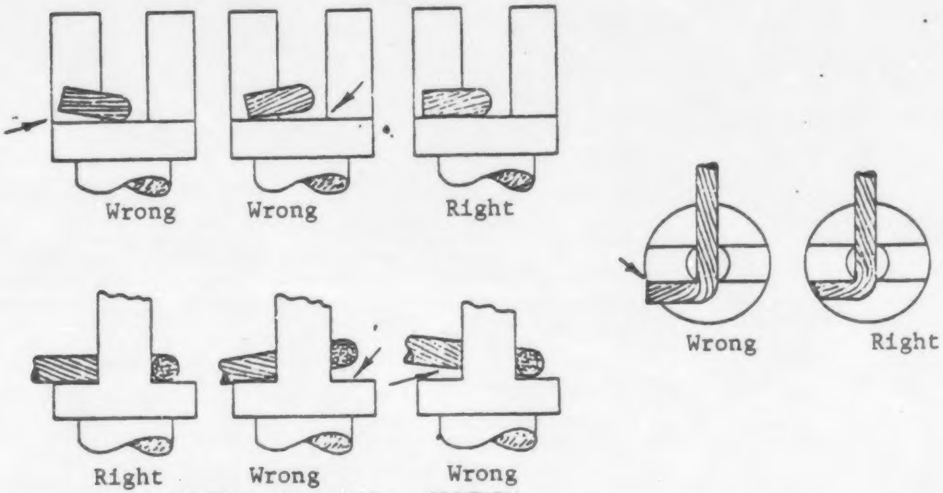
2. Wire position

a. The side entry single wire connection has the following positioning specifications:

(1) The wire shall be in contact with the surface of the terminal base as seen from front and side views.

(2) The wire wraps around one ear of the terminal and is in contact with the inside edge and one side of that ear.

(3) The wire is flush cut and does not overhang the edge of the terminal base.



BIFURCATED-TERMINAL LEAD POSITION

b. The side entry multiple wire connection has the same positioning specifications as the single wire side entry with the following additional requirements:

(1) Additional wires are wrapped in an alternating pattern to the two ears.

(2) Wires other than the bottom wire must contact the terminal ear as specified for single connections, but will not contact the terminal base.

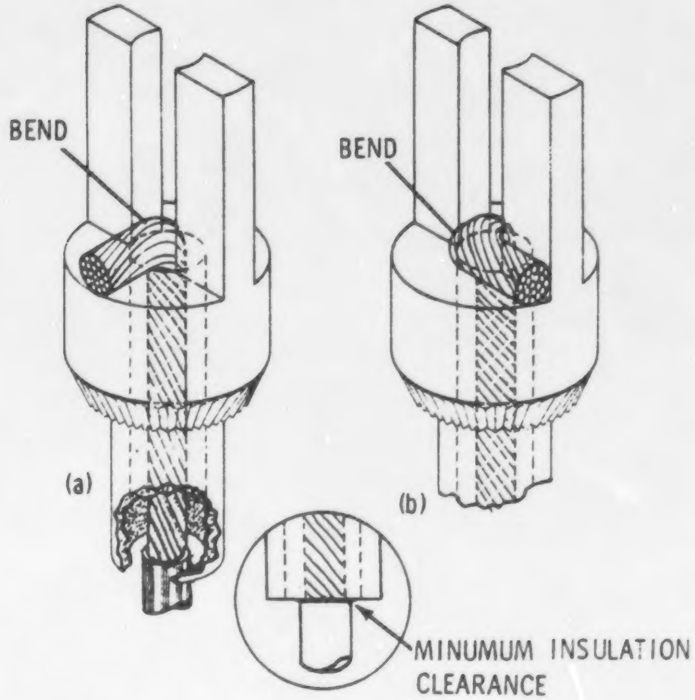
(3) All wires enter the terminal from the same side and must be parallel to each other.

c. The bottom entry connection has the following positioning specifications.

   (1) The wire must be in contact with the surface of the terminal base from the edge of the hole out to the edge of the hole.

   (2) The wire must be cut flush with the edge of the base and must not overhang.

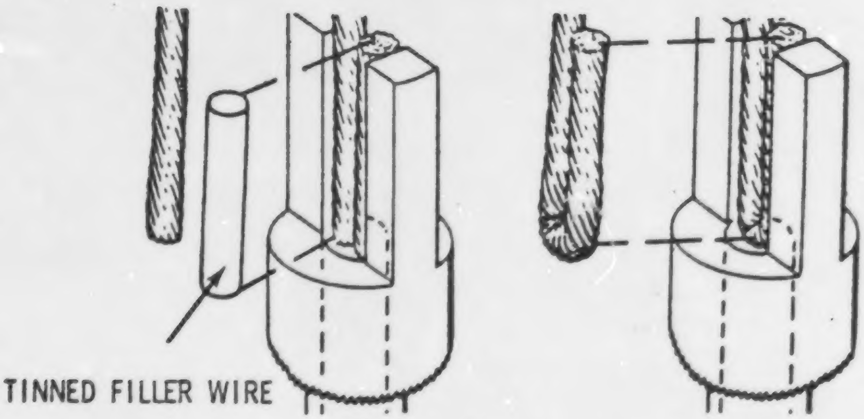
   (3) The wire should lie in a line drawn straight through the gap between the ears of the terminal.



d. The top entry connection has the following positioning specifications:

   (1) The cut end of the wire shall be level with the surface of the base of the terminal.

   (2) The wire shall be exactly in line with the hole through the base of the terminal.



e. Insulation clearance for all styles of bifurcated terminal connections shall be the same as that given for previous terminals.

3. Area to be soldered

   a. The entire surface of the base must be wetted.

   b. Smooth fillets must be formed between the wire and the terminal at all areas of contact.

   c. There must be no copper showing on the cut end of the filler wire.

   d. In all cases, solder must be flowed entirely over the hole through the base of the terminal, but no solder may flow through the hole beyond the bottom edge of the terminal base.

4. Solder quantity

   a. All solder fillets must be concave

   b. There must be no solder on any portion of the terminal other than those given as areas to be soldered.

   c. The contours of the wires and the individual strands must be visible.

E. Techniques for making high quality bifurcated terminal solder connections.

1. Application of flux

   a. Flux contained within the solder is normally sufficient for soldering a properly cleaned and prepared connection.

   b. External flux may be used if desired; however, its use greatly increases the chance of solder wicking up under the insulation.

2. Proper heat

a. The proper heating source is determined by choosing a tip size and element wattage appropriate to the mass being soldered.

b. Proper heat flow is established by using a clean, dry iron and forming a heat bridge.

3. Application of solder

a. For proper application of solder, bring a clean, dry iron into contact with the terminal and the wire.

b. For each bifurcated terminal connection style, there is a separate technique for applying solder.

c. The solder application technique for side entry connections with a single wire is as follows:

(1) Establish the heat bridge.

(2) Thoroughly tin the surface of the base of the terminal and the cut end of the wire. Wipe the solder around the terminal to form fillets between the wire and the terminal at all areas of contact.

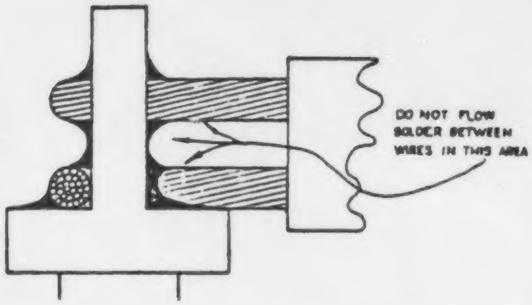
(3) REMOVE THE IRON AND CONTINUE TO FLOW SOLDER into the hole area of the terminal (using the residual heat of the terminal to melt the solder) until the hole is completely covered with solder. This will only work if the iron is removed and must be finished before the terminal cools below the solder melting point.

d. The solder application technique for multiple side entry connections is as follows:

(1) Establish the heat bridge for a multiple side entry connection.

(2) Thoroughly tin the base of the terminal, remembering that there is more than one cut wire end to be tinned. Wipe the solder around the terminal to form fillets between the wires and the terminal at all areas of contact.

(3) Cover the hole area with solder, using the same techniques used with single wire side entry connections.



e. The solder application technique for top entry connections is as follows:

  (1) Establish the heat bridge.

  (2) Thoroughly tin the base of the terminal, then wipe the solder around the terminal to form the fillets between the wire and the terminal.

  (3) The last step is to cover the hole as in the previous methods.

f. The solder application technique for bottom entry connections is as follows:

  (1) Establish the heat bridge for a bottom entry connection.

  (2) Tin the base of the terminal, and form the fillets between the wire and the terminal at all areas of contact on the base.

  (3) Cover the hole using the same techniques as with previous connections.

4. Cleaning after soldering.

  a. As always, a thorough cleaning must be given the connection after soldering.

  b. Cleaning is accomplished as described previously.

F. Inspecting completed bifurcated terminal solder connections for quality and reliability.

  1. Standards of acceptance.

    a. The following points must be examined and determined to be within specifications:

      (1) Proper wire wraps.

      (2) Correct wire position.

      (3) Solder in all the required areas.

(4) Proper solder quantity.

(5) No solder defects.

2. Indications to look for:

a. Each style of bifurcated terminal has its own indications of quality.

b. The indications for single wire side entry connections are as follows:

(1) Solder, smooth and gleaming with no pits.

(2) Concave solder fillets in the proper places.

(3) No solder wicking up the wire.

(4) No copper exposed.

(5) Wire wrap and positioning correct.

(6) Wire and strand contours visible.

(7) Hole completely filled over with solder.

c. The indications for multiple wire side entry connections are:

(1) All the indications listed for a single wire joint.

(2) Additional wires must alternate direction of wrap.

(3) Smooth flows of solder forming fillets between all wires and the ear that they are wrapped to.

d. The indications for completed top entry connections are as follows:

(1) Solder; smooth and gleaming with no pits.

(2) Concave solder fillets in the proper places.

(3) No solder wicking up the wire.

(4) No exposed copper.

(5) Wire and strand contours visible.

(6) Hole completely filled over with solder.

(7) Filler wire properly inserted.

(8) Wire positioning correct.

e. The indications for completed bottom entry connections are as follows:

(1) The same as those listed for single wire side entry connections.

(2) The wire must be free inside the shank of the terminal.

f. Insulation clearance must be checked. Clearance specifications are the same whenever insulated stranded wire is used.

(1) Minimum - not imbedded in the solder joint.

(2) Maximum - no more than two overall diameters, including the insulation.

(3) Preferred - One overall diameter, including the insulation.

3. Reasons for rejection

a. Wire damaged in any manner.

b. Solder wicking up the wire.

c. Improper solder quantity.

d. Poor wetting action.

e. Improper wire wrap or positioning.

f. Improper soldered area.

g. Solder defects.

G. Safety precautions

1. Workpiece

a. Never perform any action on the workpiece which will cause damage or degradation.

b. Keep scrupulously clean at all times.

2. Tool

a. Clean and store all tools properly.

b. Never use excessive force on any tool.

c. Use each tool only in the manner it was designed to be used.

3. Personal

   a. Beware of burns from hot tools.

   b. When using chemicals beware of skin, eye, and internal contact, and avoid excessive inhalation of fumes.

   c. Beware of the poisonous fumes from Teflon during the stripping and soldering operations.

   d. Avoid any possibility of igniting flammable chemicals or materials.

ASSIGNMENT SHEET 3-4-1A

TITLE

Soldering Connector Pins

OBJECTIVES

When you complete this lesson topic, you will be able to:

3.4.1 PREPARE connector pins for soldering by cleaning and tinning following procedures and to the standards outlined in MIL-S-45743C.

3.4.2 PREPARE wires for soldering by stripping and tinning following the procedures and to the standards outlined in MIL-S-45743C.

3.4.3 CONNECT prepared wires to connector pins using the proper tools and soldering techniques following the procedures and to the standards outlined in MIL-STD-454D, MIL-S-45743C and NHB 5300.4(3A).

STUDY ASSIGNMENT

Read and study Notetaking Sheet 3-4-1N of the Student's Guide.

STUDY QUESTIONS

1. The resistive tweezer type soldering tool has current flow through the ______________.

2. What is the main advantage of a tungsten electrode when compared with a carbon electrode when used in resistive soldering?

NOTETAKING SHEET 3-4-1N

TITLE

Solderable Connector Pins

REFERENCES

MIL-STD-454D
MIL-S-45743C
NHB 5300.4(3A)

NOTETAKING OUTLINE

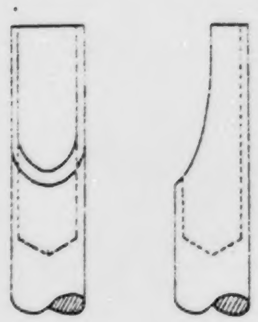
A. Types, sizes, and usage of solderable connector pins.

1. Identifying solderable pins.

a. Although most pins can be soldered, only, certain pins are DESIGNED to be soldered.

b. These can normally be identified by a curved cutout on one side of the pin.

c. Additionally, pins which have a small hole drilled in the side at the bottom of the wire socket can be identified as designed for crimping only since the small hole is for visual inspection of wire bottoming prior to crimping. The hole is not for solder inspection and will allow solder to flow out the side of the pin if an attempt is made to solder the wire.



CONNECTOR CUP
(CANNON PLUG PINS)

2. Common types and sizes.

a. Connector pin size will vary from microscopically small to so large that you would strain to lift it.

b. The common sizes you will normally encounter are those designed to accomodate wire between AWG 28 and AWG 14.

3. Purpose.

a. Connector pins serve as quick, easy disconnect points for disassembly of units.

b. Connector pins serve to pass signals and voltages through airtight bulkheads.

B. Preparing connector pins for soldering.

1. Tinning - always tin the pin prior to soldering.

a. Cleaning connector pins is difficult due to their shape; tinning is the preferred method of cleaning.

b. In addition, connector styles which have remained unchanged for years are common, resulting in replacement connectors being used which have been stored for many years and which have the resultant oxidation on the surfaces.

c. Also, when preparing a connector for reuse (changing wires), old solder must be removed.

d. The most reliable cleaning method for removing unwanted solder is to wick it out.

2. Prefilling

a. Prefilling (actually a form of tinning) is the placing of the correct amount of solder in the solder cup to form a finished solder joint. The use of preforms for consistant solder quantity is recommended.

b. This eliminates the need for a third hand to apply solder while holding the wire in one hand and the heating tool in the other.

C. Preparing wires for soldering to connector pins.

1. Tools used - the same tools as used for preparing wire for soldering any other terminal.

2. Stripping - stripping techniques are the same as for other terminal wire preparation.

3. Tinning - tinning techniques are the same as for other terminal wire preparation.

4. Bending - no wire bending is required for solder cup style connector pins.

5. Cutting to length.

a. Cutting wire to the proper length for soldering to connector pins is a relatively easy job.

b. Merely insert the wire into the connector cup to measure the length of wire needed for that size of pin.

c. Be sure that the pin used as a depth gauge is empty of solder.

d. After the first wire is cut to the proper length, it can be used as a gauge for cutting other wires of the same size which are to be used in the same size of cup.

6. Insulating tubing

    a. It is recommended that insulating tubing be used on all connector pins due to their close proximity and the danger of electrical short circuits.

    b. Insulating tubing may be either the fixed size type or the heat-shrinkable type.

    c. Heat-shrinking tubing is recommended as it provides good insulation with less bulk and is not subject to slipping up off the connection.

    d. ALWAYS insert insulation tubing over the wire prior to soldering.

    e. Tubing may be shrunk by using the solder extractor unit in the pressure mode for a heat source.

    f. Always exercise extreme caution when applying heat to shrinkable tubing (too much heat is worse than not enough).

D. Connector pin solder connection specificiations.

1. Wire wrap - as with bending, there is no wrapping to be done on connector pins.

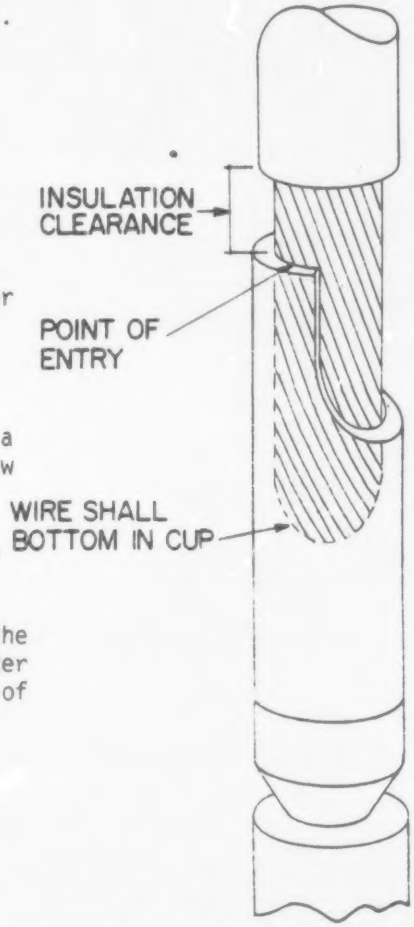
2. Wire position - the wire shall be aligned exactly with the axis of the pin cup.

3. Wire depth - the wire MUST BE BOTTOMED IN THE SOLDER CUP to prevent flux or air being entrapped in the bottom of the solder cup.

4. Areas to be soldered.

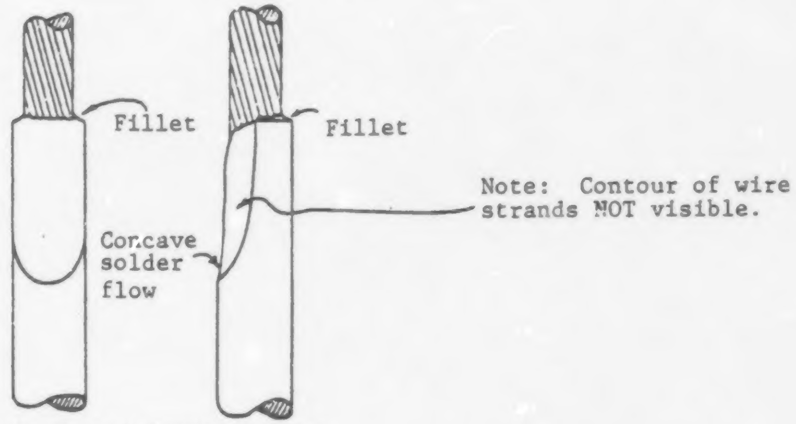
    a. The solder cup should be filled with a quantity of solder that will NOT allow the wire strands to be visible after soldering, but does not bulge beyond the confines of the cup or spill down over the sides of the pin.

    b. The edges of the cutaway portion of the cup shall be visible beneath the solder with no portion of the internal face of the solder cup showing.



c. There shall be a circular, concave fillet around the wire where it enters the solder cup.

5. Solder quantity - the solder quantity shall be such that there shall be no solder spillage onto the outer walls of the pin, and the edges of the solder flow at all points shall meet the pin or wire in a concave fillet.



Completed Connector Cup

E. Tools used to make connector pin solder connections.

1. Handtools

a. Vise

b. Antiwicking devices

2. Power tools

a. Soldering iron

b. Variac

c. Resistance soldering tweezers

d. Resistance soldering probe

F. Techniques for making high quality connector pin solder connections

1. Application of flux - except for the flux contained in the solder the application of flux is undesirable except in cases of extreme oxidation since excessive flux may become trapped in the botton of the solder cup or cause solder spilling onto the outside of the pin.

2. Proper heat

a. In soldering connector pins there are three primary methods of applying heat, all of which are reliable.

(1) Soldering iron

(2) Resistance probe

(3) Resistance tweezers

NOTE: There are two types of tips for resistance soldering, Carbon and Tungsten, each having its advantages: (1) Carbon is easier to keep clean, and provides greater heat, but is extremely fragile (2). Tungsten oxides and requires greater attention to keep clean, but is much more durable.

b. Conductive heating with the soldering iron is an acceptable method but it has the following disadvantages:

(1) The tip must be extremely clean and dry to prevent leaving solder tits on the outside of the pin.

(2) The entire heating element of the iron must be hot for it to do its work, which may burn surrounding wires and insulation.

c. Resistance heating with the probe (which heats by high current flow through the resistance of the pin itself) has the following disadvantages:

(1) It requires a second conductive lead which must be attached to some other part of the pin.

(2) Holding the single probe point against the rounded surface of the pin causes slippage which can result in severe arcing and burning of the pin.

d. Resistance heating with the resistance tweezers heats by the same method as the probe and has only the one disadvantage of arcing if misused.

e. Resistance soldering is extremely fast and efficient as a heating source and should be controlled by the following means:

(1) The current flow must be adjusted to the proper level for the thermal mass of the pin and wire.

(2) Great care must be used in adjusting the current level since most resistive heating sources are capable of pin DESTRUCTION by overheating if the current level is set too high.

(3) If using a stepped current source, fine control of generated heat is accomplished by utilizing a pumping action of the footswitch to apply power intermittently.

3. Application of solder.

a. In connector pin soldering, the wire is applied to the solder rather than applying the solder to the wire.

b. To properly apply the wire to the solder, use the following steps:

(1) The first step should be to place an antiwicking tool on the wire. The wire insulation should always be firmly bottomed in the larger section of the hole drilled through the tweezer tool head, and the jaws thoroughly cleaned of any flux or other dirt.

(2) If using the resistance heating method, thoroughly clean the tool tip with crocus cloth prior to placing the tips on the terminal as oxide buildup may cause arcing.

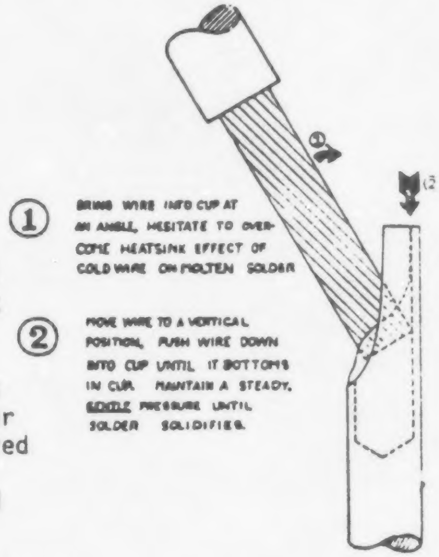
(3) You must always place the tool tip on the pin prior to applying power to prevent arcing and burning of the pin.

(4) Apply power (or the soldering iron) and observe the pin for solder melt.

(5) Upon solder melt, immediately insert the tip of the wire partially into the solder cup at about a 70 degree angle and hesitate for a second to allow heat sinking action of the wire to be overcome.

(6) After the solder remelts, VERY QUICKLY move the wire to a full vertical position and bottom it in the solder cup.

(7) Maintain a slight downward pressure on the wire until the power (soldering iron) has been removed and the solder has solidified. This downward pressure will aid in preventing the formation of stress lines in the solder.


①
②
① BRING WIRE INTO CUP AT AN ANGLE, HESITATE TO OVERCOME HEATSINK EFFECT OF COLD WIRE ON MOLTEN SOLDER
② MOVE WIRE TO A VERTICAL POSITION, PUSH WIRE DOWN INTO CUP UNTIL IT BOTTOMS IN CUP. MAINTAIN A STEADY, GENTLE PRESSURE UNTIL SOLDER SOLIDIFIES.

4. Cleaning after soldering.

  - a. As ALWAYS, the soldered connection must be properly cleaned after completion of the soldering operation.
  - b. The most effective cleaning method for connector pins is the use of a bristle brush and solvent.

G. Inspecting completed connector pin solder connections for quality.

- 1. Standards of acceptance.
  - a. Correct insulation clearance.
  - b. Proper solder fillets.
  - c. Proper solder quantity.
  - d. SMOOTH gleaming solder finish.
- 2. Indications to look for.
  - a. Preferred solder connections.
    - (1) Concave solder fillets.
    - (2) Bright, gleaming solder finish.
    - (3) Ideal amount of solder.
    - (4) No solder spillage.
    - (5) Correct insulation clearance.
  - b. No solder defects, especially stress lines, which are common in solder cup connections.
- 3. Reasons for rejection.
  - a. Improper insulation clearance.
  - b. Solder spilled over the sides of the terminal.
  - c. Arc spots on the sides of the terminal caused by improper use of the resistance soldering tools.
  - d. Birdcaged wires.
  - e. Stress lines.
  - f. Nicked or damaged wires.
  - g. Solder defects.

H. Safety precautions.

1. Workpiece

   a. Never perform any action on the workpiece which will cause damage or degradation.

   b. Keep scrupulously clean at all times.

2. Tool

   a. Clean and store all tools properly.

   b. Never use excessive force on any tool.

   c. Use each tool only in the manner it was designed to be used.

3. Personal.

   a. Beware of burns from hot tools.

   b. When using chemicals beware of skin, eye and internal contact, and avoid excessive inhalation of fumes.

   c. Beware of the poisonous fumes from Teflon during the stripping and soldering operations.

   d. Even though the resistance tools are operated at a very low voltage, there is alwyas a chance of shock if the hands are wet. Use common electrical safety precautions to prevent injury.

ASSIGNMENT SHEET 4-1-1A

TITLE

Introduction to Micro-electronic Circuit Boards

OBJECTIVE

When you complete this lesson topic, you will be able to:

4.1.1 IDENTIFY the characteristics and handling of micro-electronic circuit boards. Identification will be in complete agreement with the characteristics outlined in MIL-STD-454D.

STUDY ASSIGNMENT

Read and study Notetaking Sheet 4-1-1N of the Student's Guide.

STUDY QUESTIONS

None

NOTETAKING SHEET 4-1-1N

TITLE

Introduction to Micro-Electronic Circuit Soldering

REFERENCES

PACE Rework and Repair Technology Series
MIL-STD, 454D

NOTETAKING OUTLINE

A. Definition and scope of micro-miniature electronic repair.

   1. Micro-miniature electonics repair, as it pertains to this lesson, is any electronic repair which requires a performance skill level greater than that possessed by the "average" repair technicians.

   2. Abilities and skills to be achieved during the course.

      a. Proper identification and use of all components of the 2M micro-miniature electronic repair stations.

      b. Correct analyzation of workpiece construction and evaluation of the damage to be repaired.

      c. Identification of high quality micro-miniature solder connection characteristics.

      d. Proper utilization of tools and repair techniques to remove conformal coatings, perform desoldering operations and remove components from the workpiece.

      e. Proper utilization of tools and repair techniques to install micro-miniature electonics components on single and double sided printed circuit boards.

      f. Correct preparation, application and curing of conformal coatings.

B. Characteristics of micro-miniature solder connections on single and double sided printed circuit boards.

   1. Soldered area

   2. Solder quantity

      a. Preferred - fillets up to the half way point.

      b. Acceptable - fillets no more than the three-fourths point.

      c. Lead contours must be visible through the solder.

3. Solder finish

   a. The solder must have a bright gleaming appearance.

   b. There must be no pits, holes or other blemishes.

4. Wetting

   a. Solder must flow to the edges of the pad being soldered.

   b. Solder must blend smoothly into the soldered surface with no ridged appearance at the edge of the flow.

5. Solder defects - All connections must be free of all types of defects as described in the lesson on High Reliability Soldering.

C. Characteristics and handling of micro-miniature circuitry.

1. Circuitry characteristics

   a. There are many characteristics of electronic circuitry used today which require that the technicians performing the repair possess exceptional skill.

   b. The first characteristic to be considered is the minute size of the components and their associated circuitry.

      (1) Size is one of the most common factors requiring special skills of the repair technician since a microscope must often be used to perform or inspect the work.

      (2) Size alone, however, is far from being the only characteristic requiring special repair skills.

   c. Another common characteristic is conformal coatings which are extremely difficult to remove. This situation often requires skills well above the average level to remove the coating without causing damage to the components and the associated circuitry on the workpiece.

   d. Components which are highly susceptible to various types of damage are a characteristic of micro-miniature electonics. Components in this category require a very high skill level in handling, removal and replacement.

   e. Circuit board laminates often require above average skills of the repair technicians due to size, damage susceptibility or complexity.

   f. Another circuit characteristic which requires micro-miniature electronics level repair skills, although the circuitry and components are not "micro-miniature" as such, is high density packaging of standard discrete components.

g. A final characteristic and the one generally requiring the most skill to perform the repair, is that of extensive damage to the workpiece.

  (1) When extensive workpiece damage exists, the repair is often more a manufacturing process than a repair process. For this reason a great deal of skill is required of the repair technician when repairing extensive damage.

  (2) This type of repair action also requires, in most cases, a number of special materials which are not generally available to the average repair technician.

h. Beside the requirements for special skills, many of the characteristics of micro-miniature electronic circuits also necessitate the use of special tools. The delicacy and expense of these tools preclude their distribution to any but a select few highly trained and skilled repair technicians.

2. Proper handling techniques

a. To avoid workpiece damage, constant attention and care must be given to handling procedures both before and after the repair process, as well as during the repair process.

b. During the repair process particular attention must be given to the use of proper repair techniques to avoid causing damage to components or circuits.

c. During all stages of handling remember that someone's life generally depends upon the proper functioning of the workpiece you are repairing.

INFORMATION SHEET 4-1-1I

TITLE

Publications for use in Miniature/Micro-miniature Repair

INTRODUCTION

Some of the most valuable aids in any technical job are the publications associated with it. Many of the publications the repair technicians will need to know to perform miniature/micro-miniature repairs, which are not commonly used by technicians, who will generally be unfamiliar as to their use. The information section below is a result of knowledge gleaned from experienced repair technicians, and it explains some of the types and uses of publications associated with miniature/micro-miniature repair.

INFORMATION

There are many sources for obtaining information needed to complete a repair. These may be Naval or other types of publications. The Navy has three general types of publications that are commonly used in miniature/micro-miniature repair, which are: (1) Supply manuals, (2) Instruction manuals, and (3) Military Specifications. The specific publications and their uses are listed below:

Supply Manuals -

1. Illustrated Parts Breakdown - used to provide data needed to procure parts needed for the workpeice repair. IPB's give a detailed breakdown of all parts and hardware of a specific system, unit, or submodule.

2. Federal Stock Class Manual - used to provide data on procuring general supplies, such as tools, eyelets, wire etc. The federal stock class is a four number code (the first four digits of a national stock number) which identifies the type of item the stock number peratins to, i.e., 5905 is the federal stock class for resistors. There is an FSCM for each federal stock class, which lists all items of that class which are stocked within the supply system. The following list covers some of the most commonly used FSCM's.

   a. 5325 - Printed circuit eyelets

   b. 5120 - Handtools

   c. 5940 - Terminals and standoffs

   d. 6145 - Electrical wire

   e. 6520 - Dental supplies

Instruction Manuals -

1. Overhaul instruction manuals - contains complete maintenance procedures including parts procurement data on individual

workpieces. These are usually written on those items considered too delicate or complex for field level maintenance. The overhaul manual will list any special handling or disassembly procedures.

2. Generalized technique manuals - these manuals cover such categories as wiring techniques, repair techniques, and inspection techniques that are applicable to all types of equipment, and do not pertain to any one specific equipment, except when that type of work is being done on the individual piece.

Military Specifications and Standards -

As their name suggests, these publications are regulatory in nature and require mandatory compliance. These may either be general in nature or for a specific equipment. They provide specific instructions, acceptance standards, and technical limitations or applications for materials, processes, and techniques.

In addition to Naval publications, there are other sources for the information that a repair technicain may need to complete the repair. Some of these are listed below, along with their uses:

1. Manufacturers specification or process documents - these contain the same type of information as Military specifications, and provide the specifications that the manufacturer used to produce the equipment. They will generally list any of the Military Specificatons that apply.

2. Commercial reference texts - these are publications which provide data on general repair techniques or processes, such as soldering.

3. Commercial suppliers catalogs - used to select or procure needed repair tools or materials which are not available from the Navy supply system.

4. Government repair references - these publications are available from other government agencies, such as NASA, and provide the same type of information on repair techniques as the generalized technique manuals of the Navy.

5. Specifications or Standards - these are publications of other government agencies which serve the same purpose as Military Specifications and Standards. These are usually available from such agencies as NASA and the Marshall Space Flight Center.

SUMMARY

Many publications are needed to repair miniature/micro-miniature electronics, and the repair technician must be familiar with most of the ones listed in this sheet to do his job correctly.

ASSIGNMENT SHEET 4-2-1A

TITLE

Microminiature Repair Task Identification and Procedural Analysis

OBJECTIVE

When you complete this lesson topic, you will be able to:

4.2.1 IDENTIFY the repair task of various types of micro-electronic circuit boards by visual inspection and a procedural analysis of selected micro-electronic circuits. Identification will be in agreement with the connections listed in Volume 6 of the PACE Rework and Repair Technology Series.

STUDY ASSIGNMENT

Read and study Notetaking Sheet 4-2-1N of the Student's Guide.

STUDY QUESTIONS

None

NOTETAKING SHEET 4-2-1N

TITLE

Micro-Miniature Repair Task Identification

REFERENCES

MIL-STD-454D
PACE Rework and Repair Technology Series

NOTETAKING OUTLINE

A. Circuit board construction - Only those construction details which you have not learned in previous lessons will be covered in this lesson.

  1. Extremely high density circuits.

     a. One category of module you will be required to work on, in micro-miniature electronics repair, is the type which uses standard circuitry and discrete components, but is constructed using extremely high density component packaging.

     b. The use of standard packaging, unless other complications of construction such as thick coatings or welded leads exist, is not a microminiature task.

     c. Both standard and high density packaging may be a micro-miniature repair task if the failure occurs in a high density area.

     d. The extremely high density packaging and epoxy potting used on some modules makes it necessary to use micro-miniature repair techniques on the module, even though it may only have standard size discrete components.

  2. Hybrid circuits

     a. A hybrid circuit is one which contains both discrete components and micro-miniature components.

     b. Hybrid circuits are a second category which require the use of micro-miniature repair techniques.

     c. Some of the types of hybrids are:

        (1) Discrete components and IC's.

        (2) Discrete components and ceramic printed circuits (CPC's)

(a) The CPC's may be of the thick or thin film type.

(b) Thin film is a term used to denote the method by which film circuitry (conductive, resistive, or dielectric ink) is applied to a substrate.

(c) The substrate is usually made of Alumina ceramic material which has a very high thermal conductivity, low dielectric loss even at high frequencies, and can withstand very high temperatures. The substrates are usually from 0.010" to 0.035" thick.

(d) Thin film circuitry is deposited in a vacuum by vacuum deposition (vaporizing material in a vacuum at 200 degrees to 400 degrees C.) or cathode sputtering (using an electric potential to discharge material into a vacuum).

(e) The conductor thickness is 10,000 to 30,000 Angstroms (25,000 A = 0.0001") and the width is 0.005 to 0.020".

(f) When finished, thin film circuits are coated with powered glass (fired at low temperature) or with polyurethane.

(g) Thick film circuits have the material deposited on the substrate by silk screening.

(h) The conductor thickness on thick film types is 0.005" to 0.006" and the width is 0.020" average.

3. Multilayer printed circuit boards.

a. Multilayer printed circuits (MLPCB's) are used widely in some systems to reduce the size and space taken up by interconnecting wiring.

b. Multilayer boards are made up of a series of very thin conducting and insulating layers which are laminated together to form a single circuit board.

c. The current complexity of these boards is such that computers are generally required to layout and test their physical design.

d. The individual board layers are a double sided circuit lamination of 0.002" copper on a 0.003" thick insulation layer.

e. These thin layers are pre-impregnated with epoxy and then laminated together with heat and pressure to form the finished board.

NOTE: Multilayer printed circuit boards are to be repaired ONLY by FULL micro-miniature repair technicians who have graduated from the NAVAIR Micro-Miniature Repair Course.

4. Flexible printed circuits

   a. Flexible printed circuits are a fairly recent development in circuit technology.

   b. Flexible circuits are highly reliable and seldom need repair. When repair is needed, the complexity and materials required demand that micro-miniature repair techniques be used.

   c. Flexible printed circuits are constructed of a copper conducting layer laminated between two layers of polymide plastic film. Multilayer flexible circuits are also made using the same techniques.

NOTE: Flexible printed circuits are to be repaired ONLY by FULL micro-miniature repair technicians who have graduated from the NAVAIR Micro-Miniature Repair Course.

B. Conformal coating compounds

1. Coatings on micro-circuits.

   a. The conformal coatings you will deal with in micro-miniature repair are the same types that you learned to identify in previous lessons.

   b. The application and removal of these coatings when repairing micro-miniature circuits becomes much more critical and demand vastly increased skill levels on the part of the repair technician.

   c. Many times a coating may be technically defined as thin if measured, but it must be treated as a thick coating due to the relationship between the coating thickness and the component size.

      (1) A thin coating on a micro-miniature circuit, which is extremely difficult to remove from around the circuit component leads, must also be removed nearly 100% to enable desoldering tools to properly contact the solder pad area.

      (2) Any coating which must be removed from micro-miniature circuits should have removal performed using only micro-miniature repair techniques due to the danger of damaging the components or workpiece.

2. Extremely thick coatings

   a. Extremely thick coatings are not often encountered on circuitry using micro-miniature components unless they are completely potted or encapsulated with the coating.

   b. You will, however, occasionally encounter micro-miniature modules with extremely thick coatings such as polyurethane and epoxy.

3. Opaque coatings

   a. Opaque coatings are very common in micro-miniature electronic circuitry.

   b. Opaque coatings are generally used to completely pot or encapsulate either individual components or the entire module.

   c. The majority of conformal coatings are not opaque; thus, most opaque coatings are deliberately made opaque by manufacturers for one of the following reasons:

      (1) Opaque coatings are used on highly classified circuitry as a security measure.

      (2) Opaque coatings are also used by manufacturers to maintain security of unique design and manufacturing processes.

      (3) One of the most common uses for opaque coatings is their application by manufacturers to serve as a detriment to repair. This is done so that the circuits will be replaced rather than repaired.

4. Special coating additives

   a. In addition to additives which make coatings opaque, there are additives used which increase the adhesion strength of the coating and make penetration more difficult.

   b. One typical additive is aluminum oxide particles. These particles are mixed with the coating while it is in a liquid state. When the mixture is cured, it forms a compound so hard and abrasive that is will rapidly dull even diamond-tip instruments. This compound is most commonly used by manufacturers to protect trade secrets or to prevent repair.

c. Another common additive is powdered silica (sand). This additive forms a coating compound even harder than aluminum oxide. Diamond-tip cutting instruments are completely useless for this compound. This is most commonly used for security purposes on highly classified equipment.

C. Micro-miniature component characteristics

  1. Heat sensitivity

    a. Nearly all micro-miniature electronic components are highly susceptable to damage by heat.

    b. If the internal parts of a micro-miniature component are allowed to reach soldering temperatures for even a short period of time, damage will result.

  2. Electrical sensivity

    a. Except for a very few high power or high voltage devices, all micro-miniature electronic components may be damaged by extremely small electrical potentials.

    b. In addition to powered circuits, these potentials may be developed from such things as stray voltages on power soldering tools or static electricity from your fingers.

    c. To avoid damage, constant care must be taken to ensure that no stray voltage potential of any sort is allowed to contact component leads.

    d. Particular care must be taken with normal circuit operating potentials since they will almost invariably cause damage if applied to the wrong leads.

  3. Mechanical sensitivity

    a. All micro-miniature electronic components are sensitive to, and easily damaged by, mechanical stresses.

    b. The delicate crystalline structure of the IC chip and the glass hermatic seal around leads are both easily damaged by stresses such as dropping the component or cutting the leads with dull cutters.

    c. Excessive force or stress, applied when positioning the component or bending leads, is one of the most common causes of damage.

  4. Physical size

a. There are literally thousands of different size/shape combinations used in making micro-miniature electronic components.

b. During the previous lessons, you have been shown the most common shapes of these components.

c. Their size varies to such a great extent that it is not practical to attempt to show all the variations. Size may range from an inch or more to such microscopic dimensions that it is nearly impossible to distinguish the component with the naked eye.

D. Solder joint construction

1. Through board joints.

a. During previous lessons you have been shown most of the through board solder connection sytles, but there are some styles used with micro-miniature electronic components which you are not familiar with.

(1) The entire pad diameter of some solder joints may be only approximately 0.025". It is extremely difficult to avoid damage when soldering and desoldering through board joints on circuitry of this size.

(2) Due to the small size, and inaccurate drilling, some pads may be drilled off center during the manufacturing process, resulting in a knife edge thinness of some pad edges. Extreme care must be used to avoid lifting or breaking these pads during repair operations.

2. Surface joints

a. Surface type joints are commonly called lap joints.

b. In this type of joint the component lead is placed or lapped on top of the solder pad area and soldered into place.

c. All connection and bonding in the surface or lap joint is formed by the solder itself. For this reason the quality and strength of the solder connection in this type of joint is exceptionally critical.

d. Surface joints are a very common mounting style for IC's and other micro-miniature electronic components.

3. Circuit board solder cups

   a. Circuit board solder cups are a hollow standoff similar to a connector pin.

   b. The purpose of the solder cup is to act as a connection point for several component leads when vertical component mounting is used.

   c. Solder cups are not micro-miniature, but they are normally found on a module whose packaging density requires micro-miniature tools or techniques for repair.

4. Welded leads

   a. Welded leads are a fairly common occurrence as a mounting style for micro-miniature electronic components.

   b. Welds will either be parallel gap or point contact style.

      (1) The most common weld currently in use is the parallel gap style. It is generally used when only one of the conductors to be joined is free to move. This style is readily identifiable as it leaves a thin black line across the welded lead. A parallel gap weld is formed by bringing two parallel tips into contact with one of the leads to be joined and passing a high current pulse between the tips.

      (2) Point contact welding is an older style and is generally used where both conductors to be joined are free to move. The point contact weld is formed by bringing two tips together so that the conductors to be joined are pressed between the tips. Only very careful inspection will show that this type of joint is welded rather than soldered.

E. Evaluating repair tasks and procedural steps

1. Workpiece analysis

   a. You have been taught in previous lessons that before taking any action towards the repair of a workpiece, both the workpiece and the job to be done must be thoroughly analyzed and a complete plan of action decided upon.

   b. At this point in the course, you have been taught the information needed to enable you to make a complete analysis of micro-miniature electronic workpieces.

   c. When making an analysis of each workpiece, you are performing the most important part of insuring that no additional damage or degradation is incurred on the workpiece as a result of your repair actions.

2. Damage evaluation

   a. The next step of your preparation for repair is to locate all damage or degradation on the workpiece, and determine their extent.

   b. The nature of all damage and the area affected must be determined before you can effectively outline the repairs to be performed.

3. Task determination

   a. When the workpiece has been completely analyzed and all damage evaluated, you will have the information needed to decide what repairs must actually be performed on the workpiece.

   b. In determining the repair task (or tasks) remember that all steps taken in disassembly, repair and reassembly are a part of the overall repair task.

4. Procedural outline - The final step in preparation for repair is to combine the information gained from analyzing the workpiece, the damage and the repair task into a single comprehensive step-by-step repair procedure.

ASSIGNMENT SHEET 4-3-1A

TITLE

Micro-electronic Circuit Conformal Coating Removal and Desoldering Techniques

OBJECTIVES

When you complete this lesson topic, you will be able to:

4.3.1 EVALUATE the repair task to be performed and DETERMINE the proper conformal coating removal method to be used on micro-electronic printed circuit boards. Evaluation and determination will be based on information contained in Volume 6 of the PACE Series.

4.3.2 REMOVE various conformal coatings from micro-electronic printed circuit boards using the chemical, heat and abrasive methods and the proper tools as outlined in Volume 6 of the PACE Rework and Repair Technology Series.

4.3.3 DETERMINE the proper desoldering and component removal method to be used on selected micro-electonic printed circuits utilizing information contained in Volume 6 of the PACE Series.

4.3.4 DESOLDER various types of micro-electronic printed circuit solder connections using the wicking and motorized vacuum extraction methods of desoldering and the proper tools as outlined in Volume 6 of the PACE Series.

STUDY ASSIGNMENT

Read and study Notetaking Sheets 4-3-1N of the Student's Guide.

STUDY QUESTIONS

None

NOTETAKING SHEET 4-3-1N

TITLE

Micro-Electronic Circuit Conformal Coating Removal and Desoldering Techniques

REFERENCES

PACE Rework and Repair Technology Series, Vol. 6
MIL-STD-454D

NOTETAKING OUTLINE

A. Conformal coating removal techniques

1. Heat removal

    a. You have been taught in previous training that the careful application of controlled heat can be used to remove many conformal coatings. This is also true in micro-miniature electronic repair.

    b. The heat removal methods and tools which you learned to use on standard miniature modules is not practical for removing coatings from micro-miniature electronic modules due to the size and spacing of the components.

    c. In this lesson you will learn to apply controlled heat using the more specialized tools and techniques which are applicable to micro-miniature electronic circuitry.

2. Abrasion removal

    a. Mechanical abrasion is another useful method of removing coatings, but once again, the tools and techniques you have already learned to use are not suitable for micro-miniature electronic circuits.

    b. You will learn to use the improved tools and techniques to remove coatings from micro-miniature electronic circuits by mechanical abrasion.

3. Chemical removal

    a. The use of solvents to remove coatings is very limited, since those solvents which are strong enough to dissolve coatings also tend to attack some of the components.

    b. Always use only the solvents and procedures for coating removal which are recommended in the coating manufacturer's specifications, keeping in mind that some of the components may still be damaged by that solvent.

853

B. Use and capabilities of coating removal tools

1. Hot air jet

   a. The hot air jet technique is one of the most versatile coating removal methods.

   b. The hot air jet technique uses the solder extractor in conjunction with low air pressure.

   c. The equipment is set up as follows:

      (1) Adjust the voltage control for the extractor to obtain the desired temperature.

      (2) Connect the extractor air line to the pressure output and turn the pressure control to get minimum air flow.

      CAUTION: At maximum voltage the air temperature is approximately 1000 degrees F. and can cause great damage to the workpiece if improperly used.

   d. To remove coatings with the hot air jet, proceed as follows:

      (1) Blow hot air from the extractor tip onto the area to be removed. Keep the extractor tip approximately 1/2 inch away from the surface.

      (2) Use extreme care not to cause damage to the workpiece.

      (3) Using an orangewood stick or a similar tool, push the coating away as it softens or overcures from the hot air jet action.

   e. Using the hot air jet and a fine pointed tool, coatings can be removed from even the most minute areas.

2. Thermal parting

   a. Another very versatile heat removal tool is the thermal parting unit.

   b. To prepare for thermal parting, proceed as follows:

      (1) Connect the thermal parting tool to the low voltage A.C. output.

1530

(2) Depress the footswitch.

(3) Adjust the output control until the parting tool tip is at a temperature just below the melting point of solder.

CAUTION: ALWAYS begin the adjustment procedure with the output control set at zero to avoid damaging the parting tool.

(4) The temperature may now be adjusted slightly up or down to obtain the best results with the particular coating being removed.

c. To remove coatings with the termal parting tool, proceed as follows:

(1) Remove the coating from around the component body by overcuring and pushing the coating aside with the hot parting tip. The tip should not be hot enough to cause scorching or discoloration of the coating.

(2) Carefully remove the coating from around the leads, being very careful not to touch to board surface. The coating need only be removed down to the widest point of the component body, and from the pad area on a double sided board. The coating must also be removed from the pad area on the termination side of the board, on both single and double sided boards.

(3) If you are removing a failed component, the leads may be cut at this time. This destructive removal method is preferred when removing a KNOWN defective part, as it is the method which normally provides the lowest risk of workpiece damage.

(4) When the component leads have been cut, the component body should be heated, causing the remaining coating to soften and permit easy component removal.

(a) One method of heating the body is to use the thermal parting tool.

(b) A temperature controlled soldering iron or the hot air jet are reliable methods of heating the component body.

(5) Once the component body has been thoroughly heated to weaken the coating bond, it may be removed by gripping it with a pair of pliers and applying a gentle twisting or rocking force. Never use a pulling or lifting force as it could result in board or conductor damage.

(6) When the defective component has been removed, the leads must then be desoldered and removed from the board.

(7) After the part is removed from the board, the surface area of the board must be smoothed and cleaned to accept the replacement part. This smoothing may be done with the thermal parting tool, or by abrasive grinding methods.

(8) If non-destructive component removal is necessary, the same basic procedure is followed using two additional steps.

  (a) When removing the coating from the component leads, remove the coating down to the pad area, exposing the solder connection.

  (b) Completely desolder the component leads prior to heating the component body for removal.

3. Abrasive removal

a. The motor tool is another reliable method of removing conformal coatings.

b. A wide variety of bits are available for use with the motor tool. These bits allow the removal of various coatings from many different surfaces.

(1) The ball mill type bit is generally used only to take off the majority of a thick coating.

  (a) Small ball mills may also be used to remove coating materials from confined areas around component bodies.

  (b) When removing a coating with a ball mill, use EXTREME CAUTION and NEVER attempt to remove a coating completely with this method.

(2) Abrasive grinding bits may be used to remove coatings from small conductors or large flat surfaces, with less chance of damage than a ball mill.

  (a) The rotary bristle brush is generally the most reliable method of removing coatings from confined areas since it is small and will form itself into the shape of the area it is in contact with.

(b) The rotary bristle brush is an excellent tool for removing thin coatings completely down to the board surface without causing damage. Do not be deceived by the apparent softness of the brush, as it is highly abrasive and will cause serious damage to the laminate and conductors if it is applied with undue pressure.

C. Desoldering micro-miniature solder connections

1. The majority of all damage caused during the repair cycle of a module has always happened in the disassembly (component removal) phase of the work, and the largest percentage of this damage has occured during a single operation, DESOLDERING OF COMPONENTS. The following are reliable methods of desoldering: continuous vacuum; pressure; and the motor tool in certain cases.

2. Vacuum desoldering

   a. Of all the various methods of solder extraction currently in use, the most versatile and reliable is the continuous vacuum method. Tools using this method have been found to greatly outperform all other methods for general use when operated by trained personnel.

   b. Much desoldering which is very difficult or nearly impossible to perform RELIABLY with other methods is a routine matter using the continuous vacuum extraction tools.

3. Pressure desoldering

   a. As you have learned, hot air at approximately 1000 degrees is available when using the extractor in the hot air jet mode.

      (1) The hot air jet can be used to blow solder out of dead end holes when vacuum will not do the job.

      (2) The hot air jet also allows you to melt solder and remove lap-soldered leads from a distance if they are inaccessible. It also allows the lead to be desoldered without touching the hot tip to the joint when the pad or board laminate are extremely sensitive to heat and pressure.

4. Removal of welded leads

   a. It is often necessary in micro-electronics to repair modules with welded component connections, even though we do not have welding or dewelding capabilities.

   b. Using the tools and techniques taught in this course you will be able to remove welded leads and install replacement components by soldering.

D. Use and capabilities of desoldering tools

1. Solder extractor - You have already been trained in the proper use of the solder extractor as a continuous vacuum device, so it is only necessary at this point to briefly review reliable extraction procedures.

   a. Always use a stirring motion of the lead if possible, so that no sweat joints remain after desoldering (this is particularly important with multilead components).

   b. Except for very rare instances where you have no alternative, NEVER allow the extractor tip to contact the board laminate, conductors or pads.

   c. The desoldering of lead terminations which are not straight through can be greatly simplified by using micro-miniature tools and techniques.

      (1) The normal process is to extract all solder possible and then mechanically hear the remaining sweat joint with pliers. The shearing operation presents some risk of workpiece damage.

      (2) The thermal parting tool may be used in place of the shearing operation. This will greatly reduce the risk of damage.

         (a) After extracting all the solder possible, adjust the parting tool to solder melting temperatures, and use it to lift (NEVER PRY THE LEAD) the lead to a straight position.

         (b) When the lead has been lifted, the extractor may be used with the stirring action to completely desolder the lead.

      (3) The new techniques of solder extraction which apply to micro-miniature repair are those of extensive extractor tip modification to allow desoldering of a wide variety of small sized and odd shaped connections. Remember that you can and should modify your extractor tips to any shape needed when it will result in more efficient solder extraction.

2. Hot air jet

   a. The hot air jet technique is extremely useful for removing lap-soldered component leads. The technique is as follows:

      (1) Connect the solder extractor to the pressure supply and set the pressure flow control to MINIMUM.

(2) Adjust the extractor temperature to MAXIMUM, and vary the amount of heat applied to the solder joint by varying the distance between the extractor tip and the joint.

(3) Gently grip the lead with tweezers and blow hot air on the connection.

(4) When a solder melt is observed, lift the lead carefully and remove the hot air flow.

(5) When correct flow, temperature and distance are used, the solder melt should occur in approximately 2 seconds. Remember to alternate the operation from one side of the component to another, so that there is no excessive buildup of heat in a single area.

3. Removing welded leads.

a. Cutting the lead

(1) The welded lead is cut between the weld joint and the component body (normally using cutting pliers) being very careful not to damage the pad or welded piece of lead which remains on the pad area.

(2) The lead must be cut at the edge of the pad area.

(3) The motor tool may be used to cut the leads when they are not accessible to pliers, but great care must be taken not to cause workpiece damage.

b. Dressing the lead

(1) When the welded component has been cut free and removed, the remaining welded lead ends must be properly dressed and prepared so that a replacement component may be soldered (rather than welded) in place.

(2) The lead tip is smoothed down flat so that is may serve as a pad area for lap soldering.

(3) Since most welded leads are gold-plated non-solderable metal, care must be taken not to damage or remove the solderable gold plating from the lead.

(4) If the lead is unplated, there are two methods of preparation which will allow soldering of a replacement component.

(a) The unplated lead may be electroplated with gold so that it becomes solderable.

(b) The welded lead may be removed completely by abrasive methods, and the replacement component lead soldered directly to the pad. This method is the least desirable for two reasons.

1. While completely removing the lead, there is a very high risk of damaging the board circuitry.

2. The pad area must be plated, or the solder joint must be allowed to have a gap on it since the area where the weld was formed will be non-solderable.

(5) The motor tool can be used to clean and smooth the lead, or to grind away the weld when necessary but must be used with caution to avoid damage.

NOTE: NEVER attempt to separate a welded joint with heat or pressure as circuit conductor damage will almost invariable result.

E. Evaluating disassembly for completeness and quality.

1. Coating removal - evaluate as follows:

a. Completeness - check that all coating removal necessary for the entire repair cycle of the workpiece has been performed, and that no part of the remaining coating will interfere with future repair, component mounting, or soldering.

b. Quality - check that no workpiece damage has been caused, and that all remaining coating is free of charring, cracking or debonding.

2. Desoldering - evaluate as follows:

a. Completeness - check that all desoldering necessary to the entire repair has been performed, and that all desoldered holes and pads are free of excessive amounts of solder.

b. Quality - check that no board or conductor damage has been caused.

3. Welded lead preparation - evaluate as follows:

a. Completeness - check that all leads have been cut, cleaned and smoothed so that they are suitable as a solder pad for replacement components.

b. Quality - check that no board or conductor damage has been caused during lead preparation and that any metallic plating (such as gold) is complete and undamaged to permit reliable soldering.

4. Workpiece damage - evaluate any damage found during the previous steps as follows:

   a. Determine if any hidden damage was discovered as a result of disassembly and, if so, incorporate its repair into the overall repair task analysis.

   b. Determine if any workpiece damage was caused by disassembly and, if so, take the following steps:

      (1) Evaluate the cause of the damage and take immediate action to insure that similar damage is not caused on future workpieces.

      (2) Incorporate the necessary repairs into the overall repair task analysis.

F. Safety precautions

1. Workpiece

   a. Follow proper workpiece handling procedures at all times.

   b. In the performance of all work strive to cause no damage and to make as reliable a repair as you are capable of.

2. Tool

   a. Properly maintain and handle all tools.

   b. Use all tools ONLY for their intended purpose.

3. Personal - exercise the proper safety precautions for all of the following potentially dangerous items which you will be working with.

   a. Electrically powered or heated tools

   b. Edged tools

   c. Rotating tools

   d. Caustic, toxic and flammable chemicals and materials.

ASSIGNMENT SHEET 4-4-1A

TITLE

Micro-electronic Circuit Soldering Techniques

OBJECTIVES

When you complete this lesson topic, you will be able to:

4.4.1 POSITION components on micro-electronic printed circuit boards using the preferred mounting procedures outlined in MIL-STD-454D.

4.4.2 SHAPE component leads for mounting on micro-electronic printed circuit boards without damaging leads or components and meeting all bend specifications as listed in MIL-STD-454D.

4.4.3 REPLACE electronic components on micro-electronic printed circuit boards utilizing the proper tools and soldering techniques for high quality solder connections following the procedures and to the standards as outlined in MIL-STD-454D.

4.4.4 INSPECT micro-electronic printed circuit solder connections on selected boards and DETERMINE that their quality and reliability are in accordance with the standards outlined in MIL-STD-454D.

4.4.5 IDENTIFY the proper conformal coating that should be applied to various micro-electronic printed circuit boards. Identification will be in complete agreement with the information contained in MIL-C-47256(M.I.).

STUDY ASSIGNMENT

Read and study Notetaking Sheet 4-4-1N of the Student's Guide.

SUTDY QUESTIONS

None

NOTETAKING SHEET 4-4-1N

TITLE

Micro-electronic Circuit Soldering Techniques

REFERENCES

MIL-STD-454D
MIL-S-45743C
MIL-S-46860(MI)
PACE Rework and Repair Technology Series

NOTETAKING OUTLINE

A. Component preparation

1. Preformed leads

   a. Many micro-miniature components today come from the manufacturer with preformed leads.

   b. Preformed leads will greatly ease your job in component preparation but they also require special handling to avoid damaging the lead configuration.

2. Specifications and standards

   a. The specifications and standards for round lead components shall be the same as those learned in previous lessons.

   b. The only additions to the specifications apply to flat leads and lap joints. The new specifications are as follows:

      (1) Leads shall contain two distinct bends at an approximate angle of 45 degrees.

      (2) The lead shall be in contact with the solder pad from the second bend to the lead tip.

      (3) The contact area of the lead shall not overhang the edge of the solder pad at any point.

      (4) The contact area of the lead must be a minimum of 1/2 the length of the solder pad.

3. Recommended forming tools.

   a. There are a large variety of forming tools for multilead components (IC's) which are satisfactory for use. Their cost is generally high, however, since a different forming tool must be used for each lead configuration.

b. For this reason, hand-forming tools are recommended in most cases.

c. All of those tools and techniques learned in previous lessons are recommended for use with micro-miniature components.

d. For bending leads of multilead components, the following tools are recommended:

   (1) Smooth jaw needle nose pliers.

   (2) Smooth jaw tweezers.

   (3) Round nose pliers

e. Some of the tools used for miniature component lead bending may be too large for the lead size of the micro-miniature components. If so, a tool of the same type but of a smaller size may be used.

4. Hand-forming techniques

a. All those forming techniques learned in previous lessons are suitable except for the forming of ribbon leads on the "Flat Pack" style of multilead components.

b. For bending ribbon leads on the "flat pack" style of multilead components use the following techniques:

   (1) Grip the leads with needle nose pliers or tweezers with the jaw edge which is nearest the component placed at the point of the first bend.

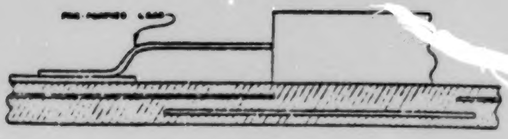
   (2) Smoothly and evenly push the component over to a 45 degree angle with your finger. Be careful not to stress the seal of the component during any step of this operation.

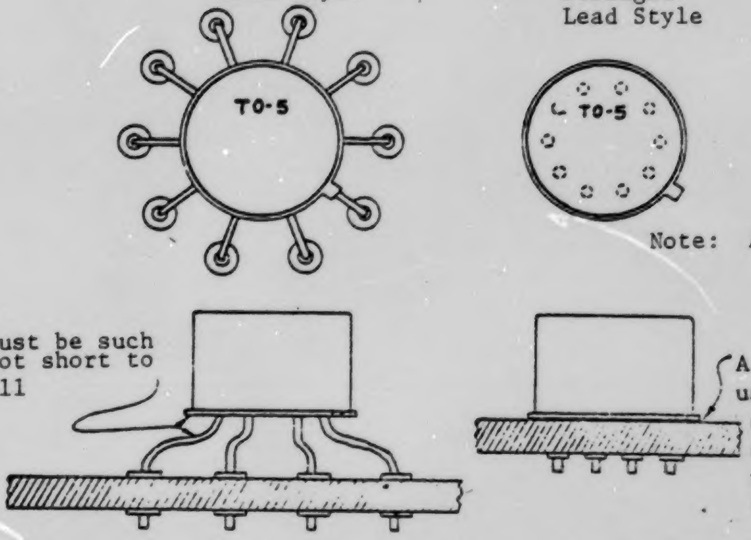
   (3) Grip the leads in the same manner at the point of the second bend.

   (4) Hold the body of the component between your finger and thumb and smoothly push the component in the opposite direction of the first bend to form the second 45 degree bend.

   (5) Repeat the previous steps on the other side of the component.

Flat Pack 1C





Note: All leads not shown.

Lead bend must be such that lead does not short to rim of metal shell

A transit pad must be used when there are conductors on the component side of board to prevent metal can from shorting runs.

Either style of TO-5 1C lead style may be used with an appropriate transit pad to provide proper lead positioning, lead to case insulation, lead to lead insulation and case to conductor insulation. Transit pad also provides a firm base to prevent component motion.

2. Lead terminations

a. All of the various lead termination styles you have learned in previous lessons will be found in micro-electronic assemblies.

b. In addition to those you are familiar with, there are some new style terminations which are very common to micro-miniature electronic assemblies.

c. The first of these is the style used in conjunction with lap-soldered joints.

d. The next type is found in some styles of vertical component mounting is called multilead circuit board connections. This is a form of hollow standoff with a solder cup used to connect several leads to the same point.

B. Component installation

1. Positioning considerations

a. Whenever possible, the component should be placed symetrically between the mounting points and have identifying marks visible.

b. The prime rule in repair, however, is to always use the same style and positioning as the original, unless it can be shown that greater reliability can be obtained by changing the positioning.

c. The final positioning consideration which is actually a dictating factor is the actual space provided for the component. This factor is particularly prevalent in micro-miniature electronics where there is often only enough space for the component to be mounted in one way.

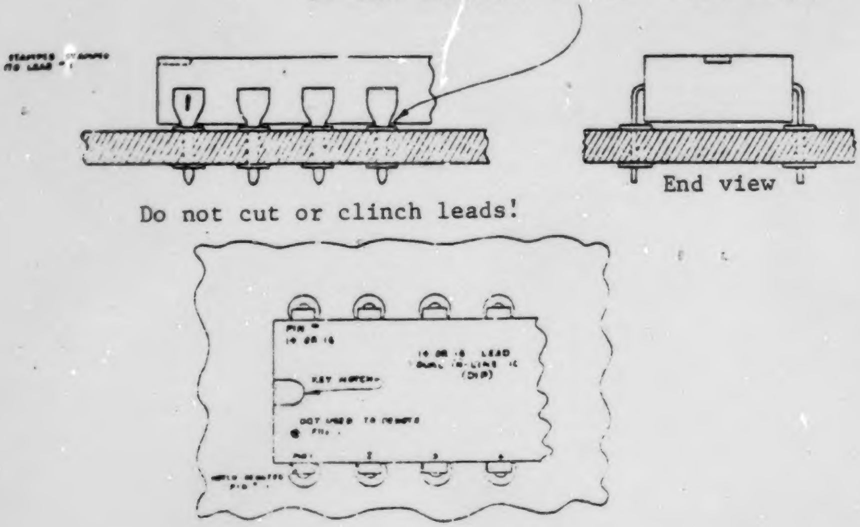
d. Positioning of IC packages depends on which style of package the IC is in. The major styles are:

(1) Dual-in-Line,

(2) Flat pack

(3) TO-5 (can)

e. The below drawings show the positioning for these three types of packages.



Leads of dip ID's shall be inserted so that shoulder of lead rests on pad.

End view

Do not cut or clinch leads!

e. The preferred style of lead termination for through-board solder joints is the straight through termination. This is to allow maximum repairability of the circuits during future maintenance.

3. Lead cutting

a. All lead ends must be cut with a flush cutting tool.

b. Scissors are the most highly recommended tool for cutting flat leads such as those on a flat pack IC, and for cutting the leads on multilead components.

(1) Scissors are ideal for cutting the leads of multilead components since they permit all leads to be cut in a single operation. This will provide a high degree of uniformity in lead length.

(2) They are also good for flat leads since they allow them to be cut with a minimum amount of torque applied to the lead. This is very important since flat leads are easily distorted by very small amounts of torque.

c. All other leads may be cut with standard flush cutting pliers.

4. Specifications and standards

a. All component mounting and lead termination specifications previously learned apply to micro-miniature electronic repair.

b. The mounting specifications for an IC may be summed up in one statement, mount it the same as the original. This is because the multilead IC packages do not permit any variation in the physical mounting of the component.

c. The specifications for a lap-soldered joint lead termination is as follows:

(1) The lead must be flush cut, with the cut being perpendicular to the long axis of the lead.

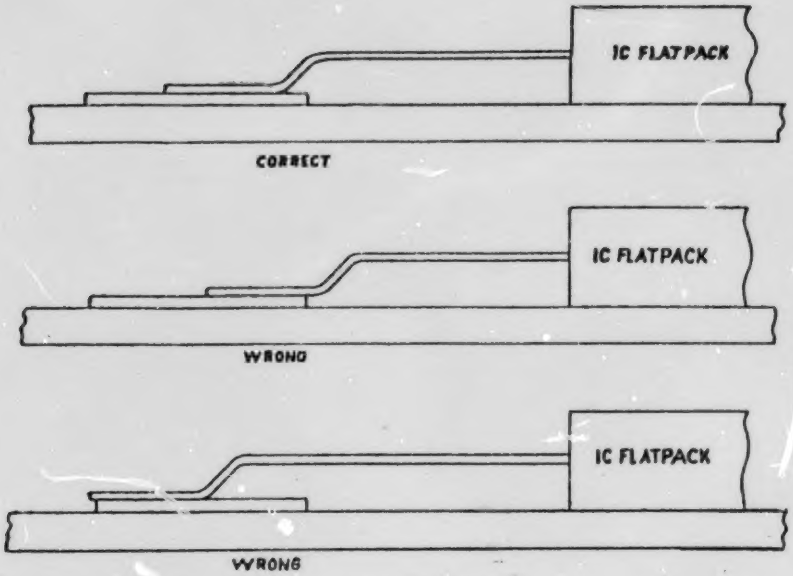
(2) No portion of the lead end may extend beyond the edge of the mounting pad.

(3) The lead must be flat on the pad surface from the heel of the second bend to the end of the lead.

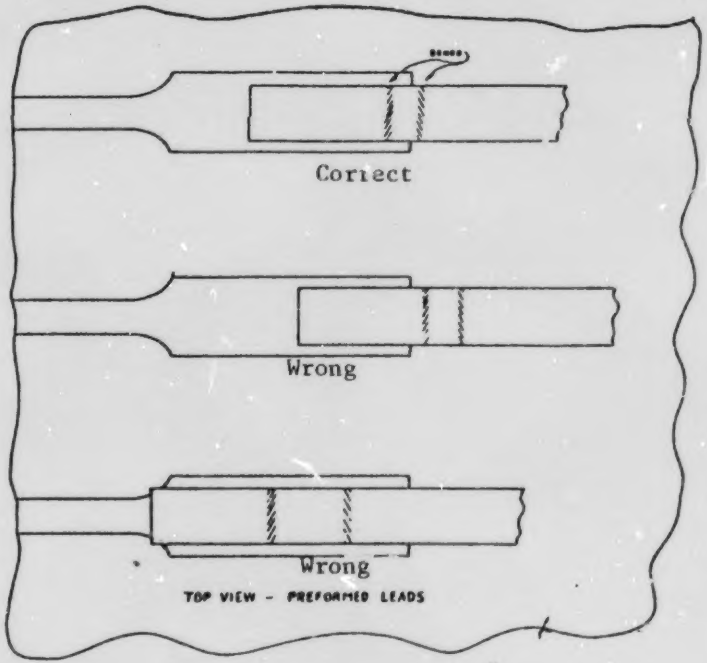
(4) The lead must be centered on the pad surface, with no part of the lead overhanging the pad edges.

(5) There must be maximum amount of lead to pad contact.

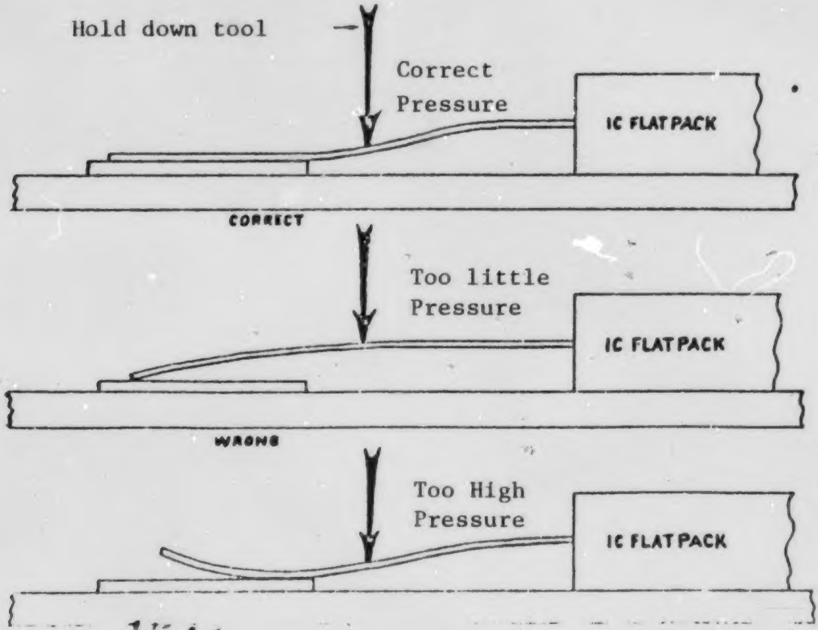
867

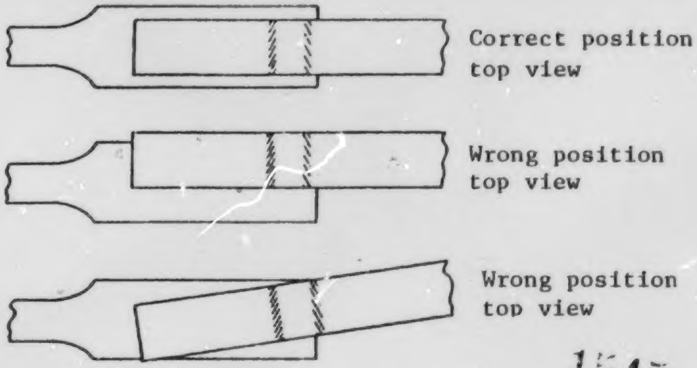

IC FLATPACK
CORRECT
IC FLATPACK
WRONG
IC FLATPACK
WRONG

EDGEVIEW - PREFORMED LEADS[3]


Correct
Wrong
Wrong

TOP VIEW - PREFORMED LEADS


Hold down tool
Correct
Pressure
IC FLATPACK
CORRECT
Too little
Pressure
IC FLATPACK
WRONG
Too High
Pressure
IC FLATPACK


Correct position
top view
Wrong position
top view
Wrong position
top view

1545

IC LEADS

1544

d. The specifications for a multiple lead termination will be as follows:

(1) All leads must enter the solder cup on a line parallel to the long axis of the solder cup.

(2) Lead ends shall be bottomed in the solder cup.

(3) All lead ends shall be cut to a length so that the lead bend, which is nearest to the solder cup, begins not less than one lead diameter above the top edge of the solder cup when the lead is bottomed in the solder cup.

(4) All leads entering a solder cup shall have the first bend, which is nearest the solder cup, an even distance above the solder cup in relation to the other leads in that cup.

e. One lead termination standard which you have previously been taught is highly important and should be re-emphasized due to its effect on the repairability of micro-miniature electronic assemblies. The standard pertains to straight through terminations.

(1) In a straight through termination the lead end must extend a minimum of one lead diameter beyond the board surface and a maximum of two lead diameters.

(2) The lead end should never be cut flush with the surface of the circuit board (despite the original design) unless a protruding lead end will cause electrical contact with adjacent parts of the assembly or other assemblies.

C. High-reliability micro-miniature soldering techniques

1. Through-board soldering

a. The soldering iron is the most effective tool for making through-board solder joints.

b. For maximum reliability a through-board solder joint should be completed within 3 seconds after application of heat. This can be accomplished by selecting the proper combination of temperature and tip mass.

c. A reliable through-board solder joint is formed by using the following techniques:

(1) Thoroughly clean all items which will contact or become part of the solder joint.

(2) Apply liquid flux to the joint area on both sides of the board.

869

(3) Apply the soldering iron tip to contact both the lead and the pad area.

(4) Form a heat bridge with clean solder.

(5) Apply solder to the connection in sufficient quantity for it to flow through the hole and complete the joint on both sides of the board in a single operation.

(6) Thoroughly clean the connection after soldering.

d. When soldering multilead components, such as IC's, use a skipping pattern to prevent excessive heat buildup in a single area of the board or component.

2. Lap-joint soldering

a. You are familiar with making lap-soldered connections on circuit conductors using a soldering iron. The use of the special lap flow soldering tool and the installation of lap-soldered ICs will be new to you, however.

b. The following steps should be used to reliably form lap-soldered connections:

(1) Prior to lap-soldering a connection, the solder pads should be cleaned and pretinned.

(2) Component leads should be tinned prior to soldering (particularly if they are gold plated).

(3) Properly position the IC on the pad areas, and tack solder two opposite corner leads to their pads to hold the component in place.

(4) Apply liquid flux to all connection points and solder each lead in place. Solder will not normally need to be added if the pads are pretinned properly.

(5) Do not forget to resolder the two tack soldered corner leads after all other leads have been soldered. Remember, also, to skip around when soldering leads so that there is no excessive heat buildup in any one area.

(6) After soldering, thoroughly clean all solder connections.

3. Soldering multiple lead solder cups

a. Multiple lead connections are soldered with the same techniques as those used on connector pins.

b. Great care must be taken when soldering this type of connection to prevent heat damage since it has a relatively large heat mass which requires considerable heat to do the soldering operation.

c. It is highly recommended that heat shunts be used when soldering this type of connection.

D. Use and capabilities of soldering tools.

1. Soldering iron

a. The soldering iron has the capability of soldering any type of soldered connection.

b. It is only necessary to learn to select the proper tip and temperature setting to gain this versatility.

c. Although capable, the soldering iron is not always the easiest and most efficient soldering tool to use. Some special application soldering tools will do the job easier and more efficiently in certain instances.

2. Lap flow soldering tool

a. The lap flow tool may solder anything from a very tiny strand of wire to a standard flat lead.

b. The proper use of the lap flow tool in making a lap-soldered connection is as follows:

(1) Set the temperature of the lap flow tool (using a practice board) so that the solder on the connection will completely melt in less than 3 seconds.

(2) Apply the tip of the tool to the connection to be soldered, using the tip to hold the lead in the proper position.

(3) Depress and hold the footswitch until the solder has melted and flowed over the connection (it is permissible to add a small quantity of solder if needed).

(4) Keeping the tip in place, release the footswitch and allow the solder to solidify. The lap flow tip is a rapid cooling, non-solderable metal which will not stick to, or damage, the connection.

c. The tip of the lap flow tool is spring-loaded to prevent excessive pressure from being applied to the joint during soldering.

E. Solder joint inspection

1. Acceptance standards

a. You have previously learned the acceptance criteria for all types of printed circuit solder joints, except for the lap-soldered connection.

b. The acceptance standards for lap-soldered connections are as follows:

(1) The outline of the component lead must be plainly visible through the solder.

(2) The solder must thoroughly cover the pad area, lead surface, lead end and lead edges.

(3) A smooth concave fillet must be formed from the pad to to the lead and lead edges and the underside or heel of the lead bend closest to the pad.

NOTE: The fillet at the heel of the lead bend provides the majority of the solder connection's strength.

(4) A smooth gleaming surface finish free of any defects with two exceptions:

(a) A depression in the surface of the solder on top of the lead is permissible if the lap flow tool was used to make the connection.

(b) Small frosty areas on the surface of the solder are permissible if the lead was gold plated.

2. Rejection standards

a. The rejection criteria for all connections except lap-soldered joints is the same as those you have learned in previous lessons.

b. The rejection standards for lap-soldered connections are as follows:

(1) Insufficient solder which occurs when the concave fillets fall below a line drawn from the pad surface to the top edge of the lead at a 45 degree angle.

(2) Excessive solder which occurs if the outline of the component lead is not clearly visible, and if any fillets are convex rather than concave.

(3) Solder spillage over the edge of the solder pad.

(4) No fillet on the heel of the lead bend.

(5) Dewetted areas on any part of the lead or solder pad.

(6) Excessive frosty appearance of the solder surface on a gold plated lead. This indicates that enough gold is present in the joint to seriously detract from its strength.

(7) Any evidence of internal solder bonding defects such as pits, cracks, roughness, etc.

(8) The connection is also unacceptable if the lead bends or positioning is incorrect.

3. Visual indications

a. All of the defects described may be detected visually by the indications described in this lesson and those taught to you in previous lessons.

b. When visually inspecting micro-miniature solder connections it may often be necessary to use the microscope to reliably check for defects due to the small size of the connection.

F. Applying conformal coatings

1. Surface preparation

a. There are several thousand different coatings on the market today, and it is totally impractical to try and teach you the proper surface preparation for each type.

b. The proper requirements for cleaning and preparation should be provided by the manufacturer of each coating and if followed explicitly will give reliable results.

2. Application techniques

a. Coatings may be either sprayed, poured or brushed onto the circuit board.

b. The type of coating, the desired thickness and the size of the area to be coated will determine which method should be used.

c. When applying coatings always follow these basic rules:

(1) Never apply the coating thicker than the original.

(2) Never apply a coating of a different type from the original.

(3) Always apply carefully so there are no bubbles or uncoated spaces in the coating.

3. Curing methods

a. As with preparation methods, there are a multitude of curing methods and it is best to follow the curing directions provided with each coating.

b. The curing time of nearly all coatings may be speeded up by heat, however, remember that the recommended curing temperature of a coating must NEVER be exceeded, and that a module should not be released from the repair shop until the coating has fully cured.

G. Safety precautions

1. Workpiece

a. Follow proper workpiece handling procedure at all times.

b. Never perform an action which will degrade or damage the workpiece.

c. Perform all work to the best of your capabilities.

2. Tool

a. Properly maintain and handle all tools.

b. Use all tools only for their intended purpose.

3. Personal

a. Exercise the proper safety precautions for all of the following potentially dangerous items which you will be working with:

(1) Electrically powered tools

(2) Edged tools

(3) Rotating tools

(4) Hot tools

(5) Caustic, toxic and flammable chemicals and materials.

874

NHB 5300.4(3A)
(Formerly NPC 200-4)
MAY 1968
EDITION

RELIABILITY AND QUALITY ASSURANCE PUBLICATION

REQUIREMENTS
FOR
SOLDERED ELECTRICAL
CONNECTIONS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

1552

875

PREFACE

Date: May 1968

In order to maintain the high standards of the NASA soldering programs, this publication:

1. Prescribes NASA's requirements for hand and machine soldering for reliable electrical connections.

2. Establishes the supplier's responsibility to train and certify personnel.

3. Provides for supplier documentation of those fabrication and inspection procedures to be used for NASA work, including supplier innovations and changes in technology.

APPLICABILITY

NASA Installations shall:

1. Invoke the provisions of this publication in procurements involving solder connections for aircraft, spacecraft, launch vehicles and mission essential support equipment, and elements thereof as appropriate to design or project needs.

2. Amend, when timely and within cost constraints, existing contracts to invoke the requirements of this publication.

3. Utilize the provisions of this publication for in-house soldering operations and, as necessary, for training and certification of in-house personnel.

4. Furnish copies of this publication in the quantities required to NASA contractors, subcontractors and subtier suppliers.

NASA contractors shall invoke the requirements of this publication in subcontracts and purchase orders.

Questions concerning application of this publication to specific procurements shall be referred to the procuring NASA installation or its designated representative.

876

This publication shall not be rewritten or reissued in any other form.

Copies of this publication are available from the Superintendent of Documents U.S. Government Printing Office, Washington, D.C. 20402.

SUPERSEDED DOCUMENTS

The following are hereby superseded:

1. Quality Requirements for Hand Soldering of Electrical Connections (NPC 200-4). Detailed soldering guidelines formerly covered by NPC 200-4 are published in the Fourth Edition of SP-5002 "Soldering Electrical Connections."

2. NMI 5330.3.

3. NMI 5330.4A.

Any NASA (including NASA installation) document, publication, regulation, etc., inconsistent with the provisions of this NHB 5300.4(3A) is hereby superseded. Also, NASA field installations will comply with the requirements of par. 4b of NPD 1410.1A in this regard.

John E. Condon

John E. Condon
Director
Reliability and Quality
Assurance

DISTRIBUTION:
SDL I (SIQ)

1554

ORGANIZATION OF THE R&QA MANUAL

OVERALL COVERAGE

The Reliability and Quality Assurance Manual--referred to as the "R&QA Manual"--is the overall generic title which identifies all NASA R&QA management publications published under the basic R&QA subject classification code. The publications are grouped by major subject breakdown and further divided into specific categories identified as Parts. These Parts (not a complete R&QA Manual) are published as individual R&QA publications.

The following list shows the grouping and initial plan for publishing the individual R&QA publications:

Part	Title	Assigned no.
	Volume I - General Provisions	
A	Reliability Program Requirements	
B	Quality Program Requirements	
	Volume 2 - Government Agency Provisions	
A	Management of Government Quality Assurance Functions for Supplier Operations	
B	Quality Assurance Requirements	
	Volume 3 - Standards	
A	Requirements for Soldered Electrical Connections (Formerly NPC 200-4)	NHB 5300.4(3A)

DOCUMENT REFERENCING

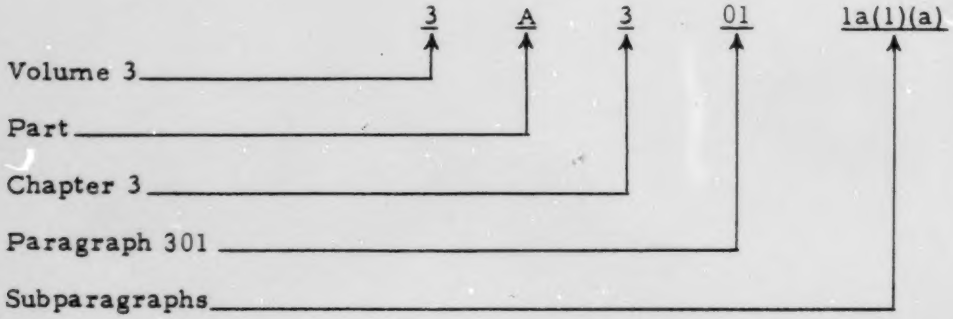
Each R&QA Manual Part is assigned its own identification number within the basic classification code. The numeric-alpha suffix within a parenthesis identifies the grouping of the publication, that is, the volume and part, such as NHB 5300.4(3A): this number indicates that this is the first "Standards" (Volume 3) publication to be issued.

When a part is revised, the suffix identification will be changed to indicate the revision number such as NHB 5300.4(3A-1).

In referencing or requesting any R&QA publication, the complete specific NHB number must be used.

PARAGRAPH REFERENCING

1. Within the R&QA Manual. The following shows the paragraph numbering system applicable to all R&QA publications.



This system provides for referencing any R&QA publication requirement (paragraph) in any other R&QA publication without the need for identifying the NHB number, title, the volume number, or part. However, when referencing a complete Part within another R&QA publication, the specific NHB number must be used.

2. In Other NASA Documents. When it is necessary to reference an R&QA publication requirement (paragraph) in any other NASA document, the specific NHB number and paragraph number must be used together as follows: "NHB 5300.4(3A), par. 3A301-1a(1)(a)," or "paragraph 3A301-2b of NHB 5300.4(3A)."

TABLE OF CONTENTS

Par. Page

Chapter 1: BASIC PRINCIPLES

3A100 Scope 1-1
3A101 General 1-1
3A102 Related Documents 1-2
3A103 Deviation and Waiver Requests 1-2
3A104 Rework 1-2

CHAPTER 2: SUPPLIER SOLDERING PROGRAM

3A200 General 2-1
3A201 Training and Certification 2-1
3A202 Maintenance of Certified Status 2-1
3A203 Recertification 2-1
3A204 Revocation of Certified Status 2-2
3A205 Vision Requirements 2-2
3A206 Workmanship Standards 2-2
3A207 Document Submittal 2-3

CHAPTER 3: FACILITIES, EQUIPMENT AND MATERIALS

3A300 Facility Cleanliness 3-1
3A301 Environmental Conditions 3-1
3A302 Lighting Requirements 3-1
3A303 Tool and Equipment Control 3-1
3A304 Heat Sources 3-1
3A305 Conductor Preparation Tools 3-2
3A306 Thermal Shunts 3-2
3A307 In-Process Storage and Handling 3-2
3A308 Materials Selection 3-3
3A309 Solder 3-3
3A310 Flux 3-3
3A311 Solvents 3-3
3A312 Terminals 3-4

CHAPTER 4: PREPARATION FOR SOLDERING

3A400 Preparation of Conductors 4-1
3A401 Preparation of Terminals and Solder Cups 4-1
3A402 Additional Requirements 4-1

CHAPTER 5: PARTS MOUNTING

3A500 General Requirements 5-1
3A501 Lead Bending Requirements 5-1
3A502 Lead Clinching, Printed Wiring Boards 5-2

Par. Page

3A503 Mounting of Parts to Terminals 5-3
3A504 Cordwood Modules 5-3
3A505 Mounting of Flat Pack Circuits 5-3

CHAPTER 6: ATTACHMENT OF CONDUCTORS TO TERMINALS

3A600 General 6-1
3A601 Wire Termination 6-1
3A602 Turret and Straight Pin Terminals 6-2
3A603 Bifurcated Terminals 6-2
3A604 Hook Terminals 6-5
3A605 Pierced Terminals 6-7
3A606 Solder Cups (Connector Type) 6-7
3A607 Solder Cups (Swaged Type) 6-7
3A608 Connection Without Terminals 6-7
3A609 Lap Joints 6-7
3A610 Insulation Tubing Application 6-7

CHAPTER 7: SOLDERING OF TERMINALS

3A700 General 7-1
3A701 Solder Application 7-1
3A702 Removal of Flux and Residue 7-1
3A703 Inspection 7-2
3A704 Acceptance Criteria 7-2
3A705 Rejection Criteria 7-2

CHAPTER 8: PRINTED WIRING ASSEMBLY SOLDERING

3A800 Fabrication and Conformal Coating 8-1
3A801 General Requirements 8-1
3A802 Printed Wiring Board Protection 8-1
3A803 Terminal Soldering 8-1
3A804 Preparation and Soldering of Termination Areas 8-2
3A805 Inspection 8-2
3A806 Acceptance Criteria 8-2
3A807 Rejection Criteria 8-3

CHAPTER 9: AUTOMATIC MACHINE SOLDERING

3A900 General 9-1
3A901 Documentation 9-1
3A902 Preparation and Assembly 9-1
3A903 Machine Requirements 9-2
3A904 Cleaning 9-2
3A905 Inspection 9-2

APPENDIXES

Appendix A: Definitions a-1
Appendix B: Typical Satisfactory and Unsatisfactory Solder Connections b-1

CHAPTER 1: BASIC PRINCIPLES

3A100 SCOPE

1. This publication sets forth hand and machine soldering requirements for reliable electrical or electronic connections. For the purposes of this document, the definitions in Appendix A shall apply.

2. This publication does not include specific requirements or specifications for the subjects listed below; however, these subjects are discussed in the paragraphs indicated as they relate to the requirements of this document. Contracts and purchases citing this publication shall contain detailed requirements to cover these items where applicable, including provisions for materials and applications suited to the intended use and environment.

   Special storage and handling (par. 3A307)

   Wire insulations, sleeving (par. 3A308, 3A610)

   Ultrasonic cleaning (par. 3A311)

   Terminals (par. 3A312)

   Special parts mounting requirements (par. 3A500)

   Potting compounds (par. 3A504)

   Cordwood modules (par. 3A504)

   Integrated circuits (par. 3A505)

   Connection without terminals (par. 3A608)

   Printed wiring (par. 3A800)

   Conformal coating (par. 3A800)

   Magnification (par. 3A703, 3A805, 3A905)

   Clean room requirements

3A101 GENERAL

1. NASA quality assurance personnel will advise and assist contractors, suppliers, NASA personnel and delegated agencies in the proper and effective implementation of the provisions of this document.

882 2. Where related requirements or changes in requirements are required, NASA quality assurance personnel will insure that the Government agency delegated to inspect at the supplier's site of fabrication has received full instructions so that the work will be inspected to the actual contract requirements.

3. Unless parts are fabricated specifically to comply with contracts or subcontracts citing this publication, internal connections of parts (as parts are defined in Appendix A) are not subject to the requirements of this publication. The supplier should assure himself that parts have suitable internal connections which will not unsolder or deteriorate when external connections are made by his processes.

3A102 RELATED DOCUMENTS

1. APPLICABLE SPECIFICATIONS. Copies of the following applicable specifications required in connection with a specific procurement may be obtained from the procuring NASA Installation or as directed by the contracting officer:

   QQ-S-571 - Solder, Tin Alloy; Lead Tin Alloy; and Lead Alloy.

   MIL-F-14256 - Flux, Soldering, Liquid (Rosin Base).

   Unless otherwise specified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

2. REFERENCE PUBLICATION. The Fourth Edition, NASA SP-5002 "Soldering Electrical Connections," contains many detailed suggestions and techniques on how to satisfy the requirements of this publication. SP-5002 is available for purchase at 30¢ per copy from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. NASA personnel should order copies through their installation technical library.

3A103 DEVIATION AND WAIVER REQUESTS

This publication requires:

1. Written approval of the cognizant NASA contracting officer or his designated NASA representative, for technical changes, deviations or waivers.
2. All deviation and waiver requests shall be supported by objective evidence and data substantiating that quality will not be compromised.

3A104 REWORK

Rework, as defined in Appendix A, is permissable unless excluded by other provisions of the contract. All rework shall meet the requirements of this publication. Rework is not repair. Repair shall be made only in compliance with applicable contractual requirements.

CHAPTER 2: SUPPLIER SOLDERING PROGRAM

3A200 GENERAL

The supplier is responsible for maintaining a documented soldering program which meets the requirements of this publication for the types of solder connections utilized in the articles involved. Portions of this publication, including illustrations, may be abstracted for the program.

3A201 TRAINING AND CERTIFICATION

The supplier is responsible for:

1. Providing necessary training of his personnel in the use of equipment employed and for insuring that all personnel who perform or inspect soldering are adequately skilled to fabricate the types of soldered connections required.
2. Certifying all personnel who perform or inspect soldering as being currently qualified to fulfill all requirements of this publication pertaining to the types of connections to be soldered. Records or evidence of certification status shall be maintained in the work area.
3. Maintaining appropriate records of training, including the certification criteria for each individual's latest certification.

3A202 MAINTENANCE OF CERTIFIED STATUS

1. The procuring Installation or its designated representative, or the supplier's instructor, may require supplier soldering personnel to demonstrate proficient workmanship on applicable hardware, or to be recertified.
2. The procuring Installation or its designated representative or the supplier's instructor, may require supplier inspection personnel to demonstrate proficient inspection performance and knowledge on applicable hardware or to be recertified.

3A203 RECERTIFICATION

1. The need for recertification shall be based on observation of the unsatisfactory quality of articles fabricated, or interruption of work period for more than 30 days.
2. Recertification shall be required when:
    a. Proficiency requirements herein are not met.
    b. New techniques have been developed which require different skills.

c. Certificate holder changes employment.

d. There is reason to question workmanship of operators or inspection performance by inspectors.

3. Procedures for recertification shall include sufficient training or retraining to enable the candidate to demonstrate proficiency in fabricating or inspecting the types of solder connections involved in his assigned work. A proficiency demonstration shall be required of each candidate.

3A204 REVOCATION OF CERTIFIED STATUS

Certifications shall be revoked for operators or inspectors when:

1. Certificate holder requires recertification according to paragraph 3A203 and fails to be recertified.

2. Supplier training program fails to meet requirements as set forth herein or as set forth otherwise in the contract.

3. Certificate holder leaves employment.

4. Certificate holder fails to meet visual acuity requirements of paragraph 3A205.

3A205 VISION REQUIREMENTS

1. The supplier is responsible for ensuring that all personnel who perform soldering or inspect soldered connections meet the following vision test requirements as prerequisite to training and to certification and recertification. The vision requirements may be met with corrected vision (personal eye-glasses). The eye tests shall be administered by qualified personnel, using standard instruments and techniques. Results of the vision examination shall be maintained and available for review.

2. The following are the minimum vision requirements:

   a. Far vision. Snellen Chart 20/50.

   b. Near vision. Jaeger 1 at 14 inches; or reduced Snellen 20/20 or equivalent.

   c. Color vision. Ability to distinguish red, green, blue and yellow colors as prescribed in Dvorine Charts, Ishihara Plates, or AOD-HRR Tests. A practical test, using color coded wires and/or color coded electrical parts as applicable, will be acceptable for color vision testing.

3A206 WORKMANSHIP STANDARDS

The supplier shall:

1. Prepare visual standards consisting of satisfactory work samples or visual aids which clearly illustrate the quality characteristics for all soldered connections involved.

2. Utilize applicable illustrations in this publication, supplemented as necessary for visual standards.

3. For approved connections other than those illustrated herein, prepare appropriate visual standards.

4. Clearly illustrate by these standards preferred workmanship and the difference between acceptable and unacceptable workmanship.

5. Make applicable visual standards readily available to concerned personnel and use them in the training program.

6. Use these standards for inspection criteria and evaluation of personnel performance.

3A207 DOCUMENT SUBMITTAL

1. Documents required herein shall be submitted to the procuring NASA Installation or its designated representative for review. Applicable supplier soldering program documents, or portions thereof, accepted on other NASA contracts shall be included to avoid duplication of effort.

2. The supplier shall describe the training and certification program he proposes to satisfy the requirements herein for the types of solder connections he will make. This description shall include the following, as applicable:

   a. Qualifications of instructors

   b. Procedures for training

   c. Lesson plan(s)

   d. Hours of instruction

   e. Procedures for certification and recertification.

3. The supplier shall document the fabrication and inspection procedures he proposes to satisfy the requirements of this publication.

CHAPTER 3: FACILITIES, EQUIPMENT AND MATERIALS

3A300 FACILITY CLEANLINESS

The supplier is responsible for maintaining soldering areas in a clean orderly condition. Smoking, eating and drinking at the work stations shall not be permitted.

3A301 ENVIRONMENTAL CONDITIONS

1. The soldering area shall have a controlled environment which limits entry of contamination. This area shall be continuously controlled as follows:

   Temperature .... 75° ± 10° F
   Relative Humidity .... Max. 60%

2. In field operations, and where soldering under controlled conditions is impractical, adequate precautions shall be taken to maintain the required quality of solder connections.

3A202 LIGHTING REQUIREMENTS

Light intensity shall be a minimum of 100 foot-candles on the work surface.

3A303 TOOL AND EQUIPMENT CONTROL

The supplier shall:

. Select tools and equipment used in soldering, and in preparations thereto, for intended function.

2. Properly clean and maintain equipment and tools.

3. Document or reference, in the supplier's soldering program, detailed operating procedures and maintenance schedules for tools and equipment requiring calibration or set-up.

4. Maintain records of tool calibration and verification.

3A304 HEAT SOURCES

1. SUPPLIER RESPONSIBILITY. The supplier shall:

   a. Choose a means of applying heat to the metals to be joined that is compatible with the size, shape, and thermal conductivity of the work pieces.

   b. Provide in operating procedures for cleanliness of the heat source to ensure uniform heat transfer and prevent contamination of the solder connection.

   c. Forbid use of soldering guns.

2. RESISTANCE-TYPE SOLDERING ELECTRODES. The surfaces of electrodes shall be kept free of dirt and corrosion.

3. CONDUCTION-TYPE IRONS. The tip shall be periodically checked for:

   a. Proper insertion.

   b. Tight attachment.

   c. Cleanliness.

   d. No oxidation scale between tip and heat element.

   e. Continuously tinned surface on the tip working surface to insure proper heat transfer and to prevent transfer of impurities.

4. NONCONTACT HEAT SOURCES. When soldering heat is applied by a jet of heated gasses, or by radiant energy beams, the supplier shall set up, operate, and maintain the equipment by established, documented procedures.

3A305 CONDUCTOR PREPARATION TOOLS

The supplier shall select and use conductor preparation tools as follows:

1. Select insulation strippers and lead bending tools which do not nick, ring, gouge or scrape conductors or damage parts.

2. Select part lead cleaning tools which do not damage leads and parts and which do not cause contamination and hinder solder wetting.

3. Use the correct size of stripping tools or machines and maintain them in calibration.

4. Verify, periodically, insulation strippers and lead bending tools for proper operation.

5. Remove defective or uncalibrated tools and strippers promptly from the work area.

3A306 THERMAL SHUNTS

Thermal shunts shall be utilized where heat from the soldering operation may degrade the quality of heat sensitive parts or of previously soldered connections.

3A307 IN-PROCESS STORAGE AND HANDLING

The supplier is responsible for proper storage and handling and providing means to prevent contamination of printed wiring termination areas, terminals, wire ends, or part leads during handling and storage. Containers compatible with materials stored are required. When handling of bare copper surfaces is unavoidable, white gloves or finger cots shall be used.

3A308 MATERIALS SELECTION

The supplier is responsible for selecting materials suitable for intended use which do not degrade the quality of the solder junction, and metals or parts being joined.

3A309 SOLDER

Solder shall conform to Federal Specification QQ-S-571, Type RA or RMA for cored solder; and type S, form B or I for solid solder, and shall be composition Sn60 - Sn63, unless otherwise required by a NASA-approved design.

3A310 FLUX

1. TYPES AND USAGE. The supplier's process documentation shall describe the types of fluxes, where each is used, and necessary precautions.

2. LIQUID ROSIN FLUX. Liquid rosin flux shall conform to MIL-F-14256, Type A, except that the copper mirror test (par. 3.5) is not required, and that the resistivity of water extract (par. 3.2.6) shall be at least 45,000 ohm-centimeters. Liquid flux used with flux-cored solder shall be chemically compatible with the solder core flux and with the materials with which it will come in contact.

3A311 SOLVENTS

1. Solvents and processes proposed by the supplier for cleaning and flux removal shall be submitted for review. Solvents shall be nonconductive, noncorrosive, and shall not dissolve or degrade the quality of parts or materials.

CAUTION!

Solvents shall not be used in any manner which will carry dissolved flux residue on to contact surfaces such as those in switches, potentiometers, or connectors.

2. The following solvents are acceptable when properly used for cleaning in soldering operations:
   a. Ethyl alcohol, ACS grade, 99.5% or 95% by volume.
   b. Isopropyl alcohol, best commercial grade, 99% pure.
   c. Trichlorotrifluoroethane, clear, 99.8% pure.
   d. Any mixtures of the above.

CAUTION!

Ultrasonic cleaning, if used, shall be employed with caution to prevent damage to parts.

3A312 TERMINALS

1. Solder terminals shall comply with the contractual specification or drawing.

2. Hot dipped, tin-lead coated terminals are preferred. Terminals with uneven or excessive coating on the mounting surfaces shall not be used as they may loosen in subsequent soldering operations.

3. Terminals shall be of proper size to accommodate the conductors. Terminals and conductors shall not be modified to accommodate improper sizes.

890

CHAPTER 4: PREPARATION FOR SOLDERING

3A400 PREPARATION OF CONDUCTORS

1. INSULATION REMOVAL. Stripping tools or machines used shall be of the correct size for the wire used and in current adjustment and/or calibration.
2. DAMAGE TO INSULATION. After insulation removal or stripping, wires shall be examined for damage such as crushing or charring. Wires with damaged insulation shall not be used. Slight discoloration from thermal stripping is acceptable.
3. DAMAGE TO CONDUCTORS. After stripping, wires shall be examined to insure that the strands have not been nicked, cut, scraped, or otherwise damaged. Damaged wires shall not be used.
4. WIRE LAY. The lay of the wire strands shall be restored if disturbed, without using bare finger contact.
5. CONDUCTORS. Conductors or part leads shall not be reduced in cross-sectional area. Part leads or solid wires shall be pretinned and shall be cleaned immediately prior to attaching. No solvent shall be permitted under the insulation. Flux shall be applied so that it does not go under the insulation except for traces carried up by solder wicking.
6. TINNING OF STRANDED CONDUCTORS. Stripped ends of stranded wires shall be tinned to prevent untwisting and separation of wire strands.
7. WICKING. Flow (wicking) of solder along the conductors is permitted but shall not obscure the wire contour at the termination end of the insulation.

3A401 PREPARATION OF TERMINALS AND SOLDER CUPS

Terminals shall be examined and cleaned when necessary immediately prior to attachment of conductors.

3A402 ADDITIONAL REQUIREMENTS

1. SOLID HOOKUP WIRE. Solid hookup wire shall not exceed a length of one inch between supports. For wires over one inch in length, attachment to a surface by conformal coating is adequate support.
2. STRESS RELIEF. Each conductor terminating at a connection point shall have an allowance for stress relief to minimize tensile or shear stress to the soldered connection or part during thermal expansion.
3. MECHANICAL SUPPORT. Wire bundles shall be supported so that the soldered connections are not subjected to mechanical loads.
4. SPLICES. Conductors shall not be spliced except as authorized by the procuring NASA Installation.

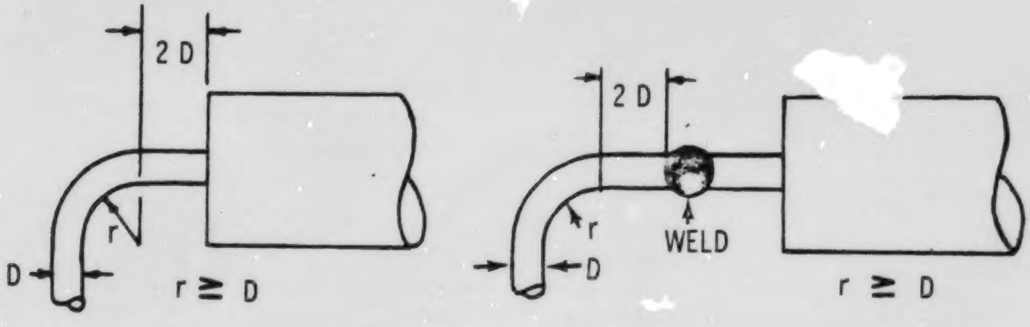
CHAPTER 5: PARTS MOUNTING

3A500 GENERAL REQUIREMENTS

1. Unless otherwise specified or approved by the procuring NASA Installation, parts shall be mounted parallel to, and in contact with the mounting surface.
2. IRREGULARLY SHAPED PARTS. When the shape of parts is such that only point contact can be made with the mounting surface, additional support shall be provided.
3. HEAVY PARTS. Parts which weigh more than 1/2 ounce (14 grams) shall be supported. Design requirements shall specify method of support or attachment.
4. METAL CASE PARTS. Metal cased parts mounted over printed conductors, or which can come in contact with each other or with other conductive material, shall be encased in transparent insulation. Such parts shall not be mounted over solder connections.
5. GLASS ENCASED PARTS. Glass encased parts (such as diodes) shall be enclosed in transparent resilient sleeving or coating material when epoxy material is used for support, conformal coating, or potting.

3A501 LEAD BENDING REQUIREMENTS

1. GENERAL. During bending or cutting, part leads shall be supported to minimize axial stress and avoid damage to seals or internal bonds. The inside radius of bend shall not be less than the lead diameter. The distance from the bend to the end seal shall be approximately equal at each end of the part. The minimum distance shall be two lead diameters. The direction of the bend shall not cause the marking on the mounted part to be obscured. Where the lead is welded (as on a tantalum capacitor) the minimum distance is measured from the weld. (See Figure 5-1).



(a) STANDARD LEAD

(b) WELDED LEAD

FIGURE 5-1--MINIMUM LEAD BEND

892 2. NONBENDABLE LEADS. Leads which cannot be bent shall be cut so that when mounted, the leads protrude through the board from 1/32" to 3/32". The contour of the end of the conductor shall be discernible after soldering. (See Figure 5-2.)

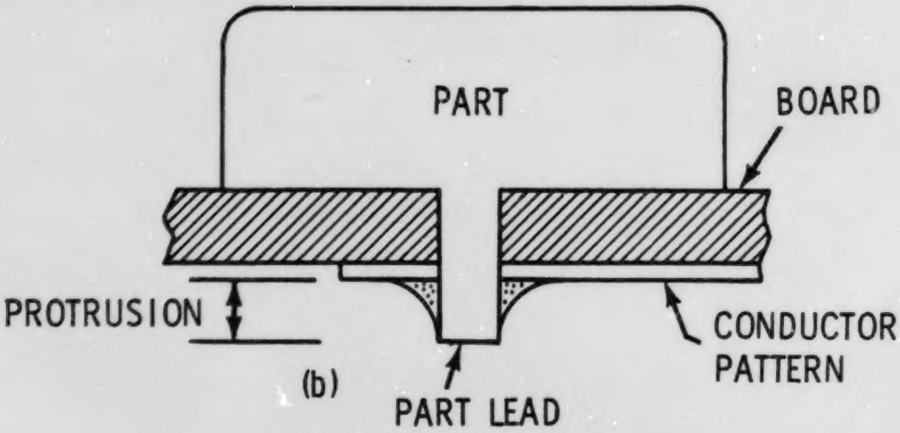

PART
BOARD
PROTRUSION
CONDUCTOR PATTERN
(b)
PART LEAD

FIGURE 5-2--NONBENDABLE LEADS

3A502 LEAD CLINCHING, PRINTED WIRING BOARDS

1. GENERAL. The clinched lead shall not extend beyond the conductor pattern edge. The clinch shall not be forced to make the conductor lie flat at the bend radius. The innate springback of the part lead is acceptable. (See Figure 5-3.)

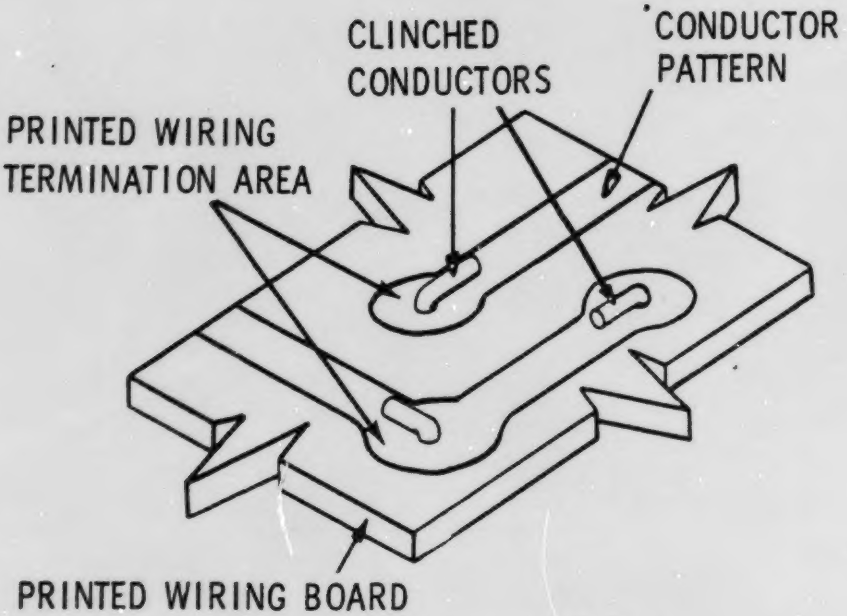

CLINCHED CONDUCTORS
CONDUCTOR PATTERN
PRINTED WIRING TERMINATION AREA
PRINTED WIRING BOARD

FIGURE 5-3--EXAMPLE OF CLINCH DIRECTION

2. ROUNDED TERMINATION AREAS. The leads shall extend through the board a minimum of the termination-area radius, and a maximum of two times the termination area radius, and shall be clinched in the direction of the conductor pattern.

3. IRREGULARLY SHAPED TERMINATION AREAS. For irregularly shaped termination areas, such as for shield and ground plane connections, the minimum clinch lead length shall be twice the diameter of the lead hole, and the maximum shall be four times the hole diameter.

3A503 MOUNTING OF PARTS TO TERMINALS

1. The length of leads between parts, and terminals shall be approximately equal at both ends, except when special part shapes, such as flanges on tophat diodes, requires staggering.

2. Each lead shall have provision for stress relief.

3. Degree of wrap, routing, and connection to terminals are specified in Chapters 6 and 7.

3A504 CORDWOOD MODULES

1. Parts in cordwood modules shall be mounted with the part axis perpendicular to the two parallel printed wiring boards.

2. Tubular parts shall be uniformly spaced between the printed wiring boards.

3. Coated parts shall be mounted so that coating on leads does not enter the mounting hole.

4. Termination of part leads shall be as specified herein, except when they are extended to serve as straight pin terminals (see paragraph 3A608), or as connections to the board on which the module is mounted.

5. Leads of heat sensitive parts shall not be used as straight pin terminals.

6. The selection and application of potting compound and the use of clinched or unclinched lead terminations shall be as approved by the procuring NASA Installation.

3A505 MOUNTING OF FLAT PACK CIRCUITS

1. The requirements of paragraph 3A502 shall not apply to the mounting of integrated circuit packages of the configuration known as "flat packs." Mounting may be on the wiring side of the boards, by lap solder joints to termination areas. Any bending of leads shall be done on suitable fixtures to prevent damage to seals.

2. Internal connections shall be suited to the intended use and environment and are not subject to the requirements of this publication.

CHAPTER 6: ATTACHMENT OF CONDUCTORS TO TERMINALS

3A600 GENERAL

1. Conductors shall be attached to terminals as illustrated in this section, which shows the requirements for routing to terminals, terminal fill, insulation clearance, and the extent of conductor wrap or bend.

2. For terminals not described or illustrated herein, similar procedures to accomplish the same intent shall be documented and submitted by the supplier for review by the procuring NASA Installation.

3A601 WIRE TERMINATION

1. BREAKOUTS FROM CABLES. For multiple wires routed from a common cable trunk to equally spaced terminals, the length of the wire ends, including vibration bend allowance shall be uniform to prevent stress concentration on any one wire.

2. MINIMUM INSULATION CLEARANCE. The insulation shall not be imbedded in the solder joint. The contour of the conductor shall not be obscured at the termination end of the insulation.

3. MAXIMUM INSULATION CLEARANCE. The maximum insulation clearance shall be less than two wire diameters including insulation but in no case shall permit shorting between adjacent conductors.

4. MULTIPLE PARALLEL ENTRY. For multiple parallel entry of wires to a terminal, insulation clearances need not be equal.

5. VARIATIONS. When characteristic impedance or circuit parameters are affected, such as in high voltage circuits or coaxial line terminations, the insulation clearance requirements may be modified. All variations shall be documented in the process procedures.

895

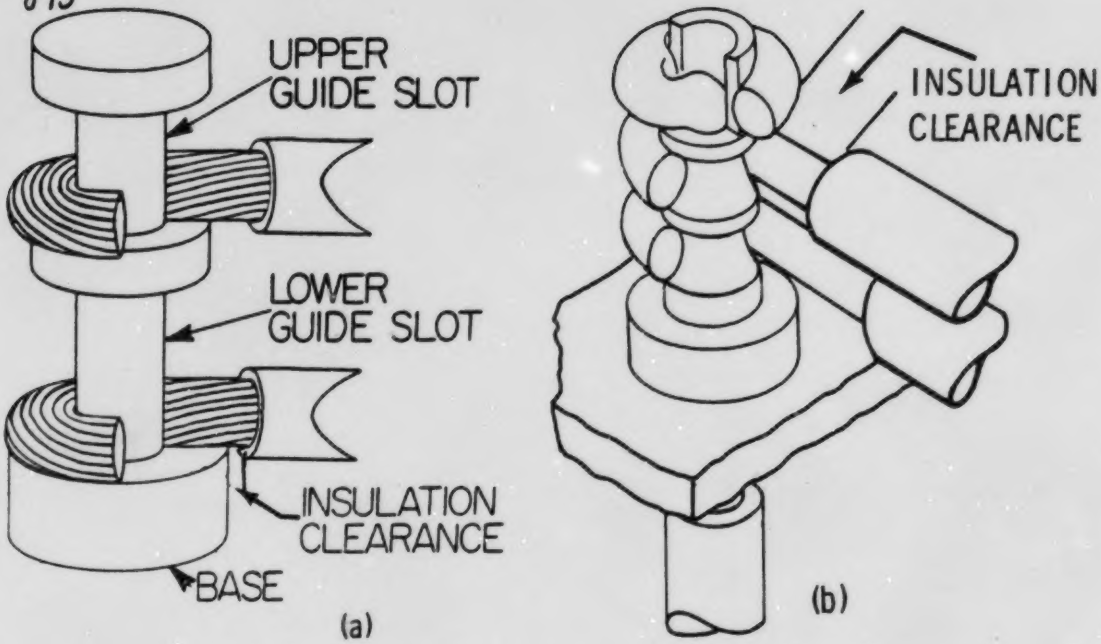


FIGURE 6-1--SIDE AND BOTTOM ROUTE CONNECTION TO TURRET TERMINALS

3A602 TURRET AND STRAIGHT PIN TERMINALS

1. SIDE ROUTE. The side route shall be connected as follows (see Figure 6-1 (a)):

   a. Conductor sizes AWG 26 and smaller shall be wrapped a minimum of 1/2 turn to a maximum of one full turn around the post.

   b. Conductor sizes larger than AWG 26 shall be wrapped a minimum of 1/2 to a maximum of 3/4 turn around the post.

   c. For turret terminals, all conductors shall be confined to the guide slots.

2. BOTTOM ROUTE. The conductor shall enter the terminal from the bottom, be brought through the side slot at the top, and wrapped as required for side route, see Figure 6-1 (b).

3A603 BIFURCATED TERMINALS

1. GENERAL. Top, side, or bottom routes, or combinations as illustrated in this chapter are permissable. Terminal side route connections shall not extend beyond the top of terminal.

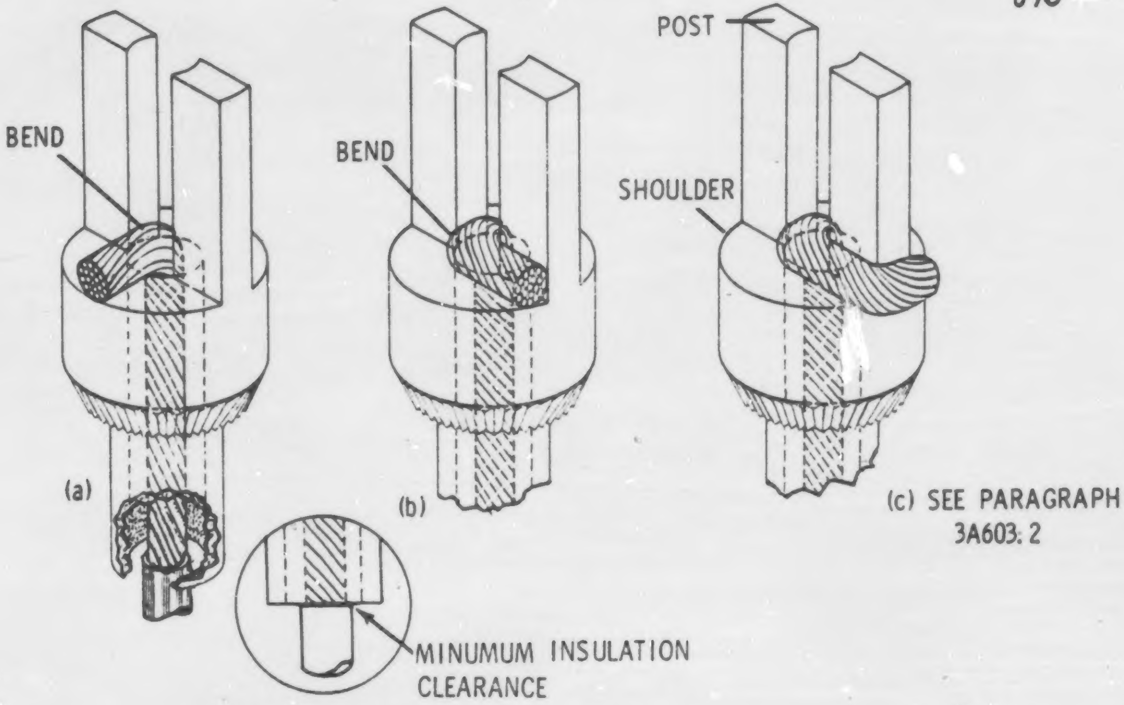


FIGURE 6-2--BOTTOM ROUTE CONNECTIONS TO BIFURCATED TERMINAL

2. BOTTOM ROUTE. Bottom route shall be connected as shown in Figure 6-2. Conductors shall not extend beyond the diameter of the base except as shown in Figure 6-2 (c), which is acceptable only when physical clearance is adequate for the intended environment and electrical characteristics.

3. SIDE ROUTE. Side route shall be connected as shown in Figure 6-3. The conductor shall enter the mounting slot perpendicular to the posts. When more than one conductor is connected to a terminal, the direction of bend of each additional conductor shall alternate. Conductors shall not extend beyond the diameter of the base except as shown in Figure 6-3(c), which is acceptable only where physical clearance is adequate for environment and electrical characteristics.

4. TOP ROUTE. Top route shall be connected as shown in Figure 6-4. Conductors which fill the gap between vertical posts shall be inserted to the depth of the shoulder. Conductors which do not fill the gap shall be accompanied by a tinned filler wire (solid or stranded) to help hold the conductor in position or shall be

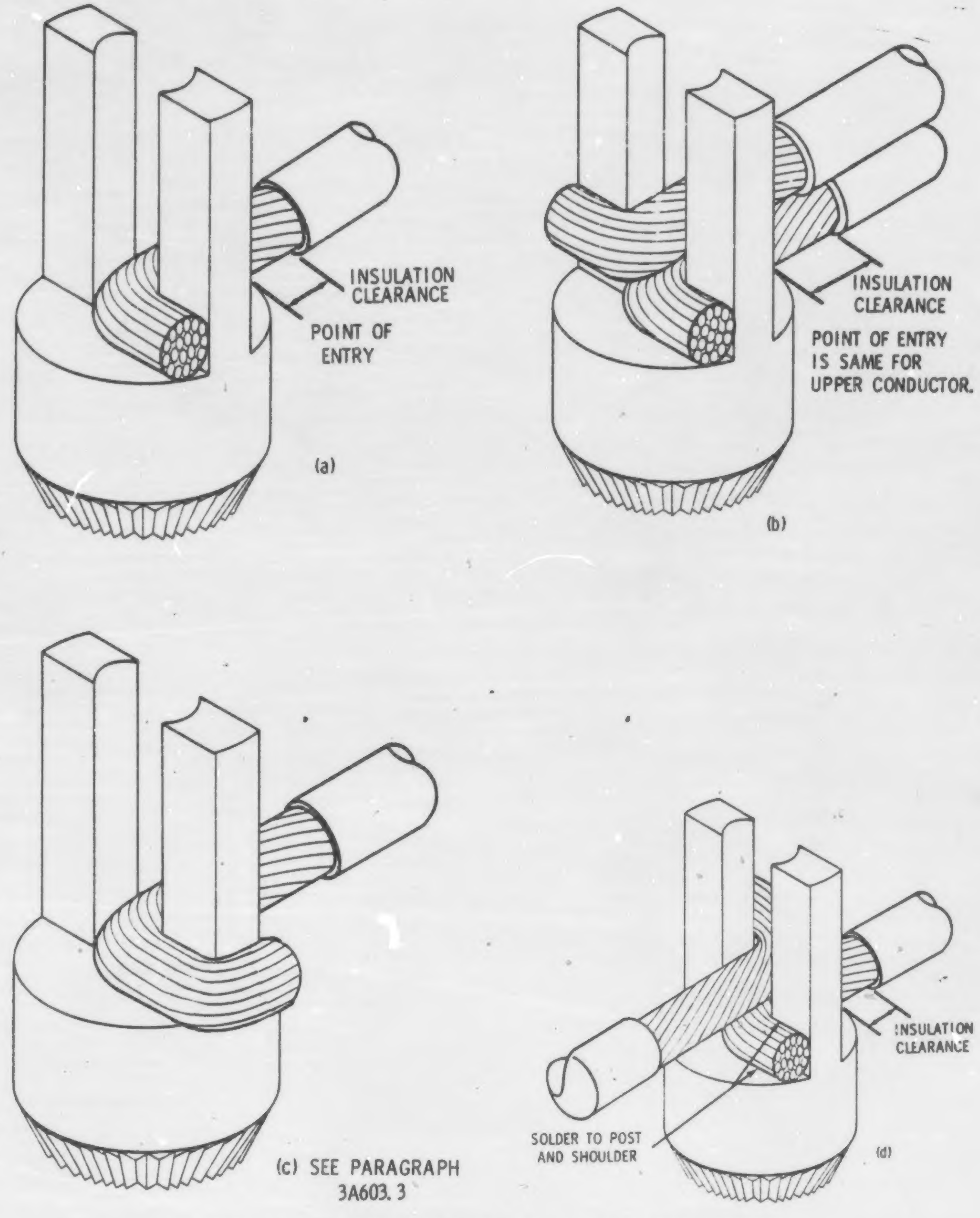

INSULATION CLEARANCE
POINT OF ENTRY
(a)
INSULATION CLEARANCE
POINT OF ENTRY IS SAME FOR UPPER CONDUCTOR.
(b)
(c) SEE PARAGRAPH 3A603.3
SOLDER TO POST AND SHOULDER
INSULATION CLEARANCE
(d)

FIGURE 6-3--SIDE ROUTE CONNECTION TO BIFURCATED TERMINAL

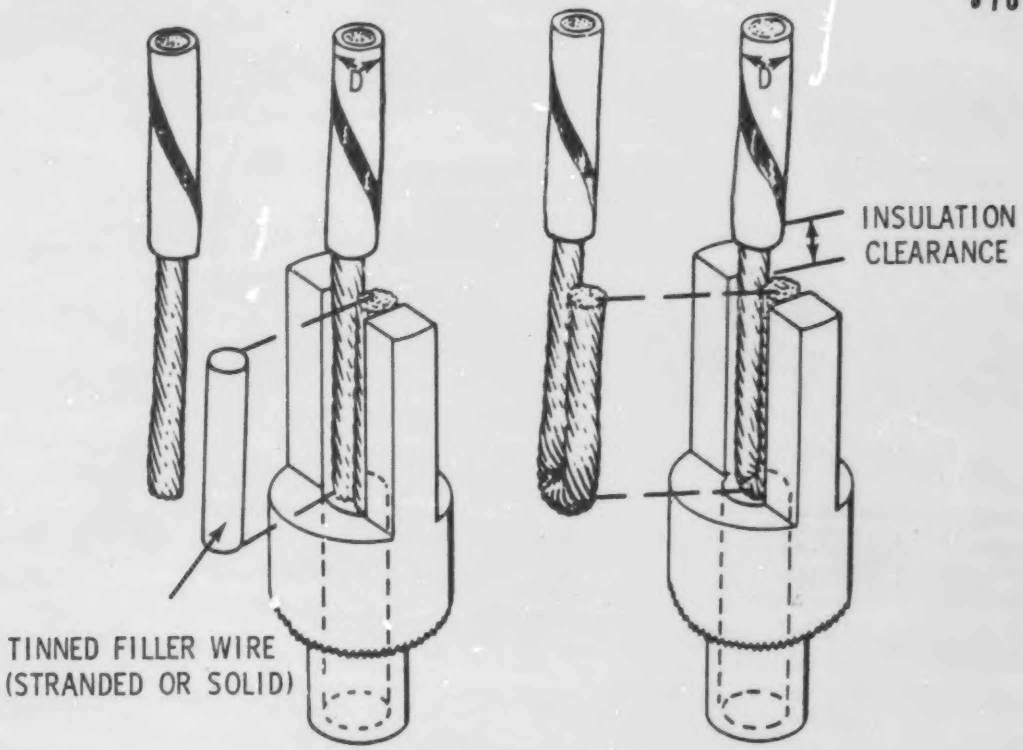


FIGURE 6-4--TOP ROUTE CONNECTION TO BIFURCATED TERMINAL

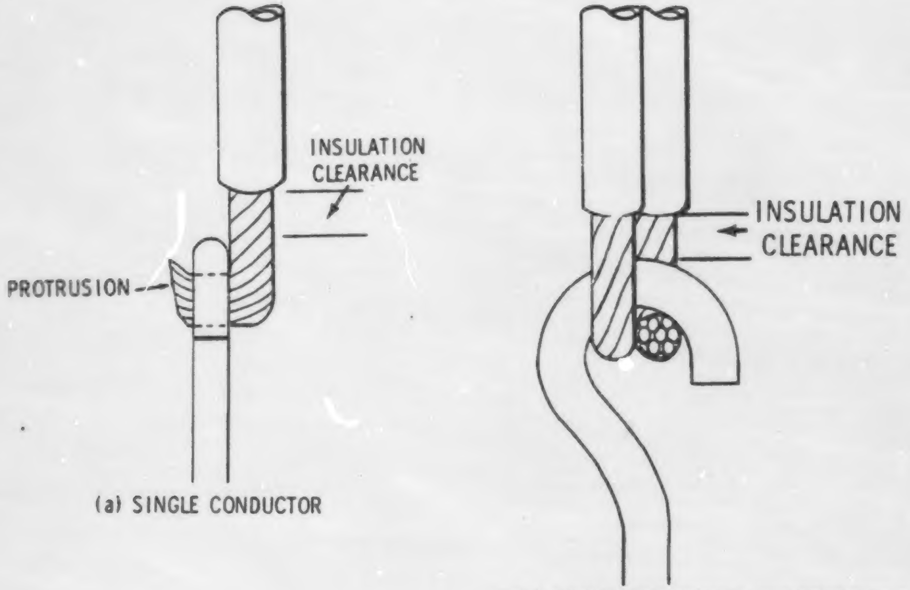
bent double as shown providing the combined diameters are sufficient to fill the gap. The top route and side route shall not be used on the same terminal. The top route shall not be used if there is sufficient room for side entry.

5. TOP AND BOTTOM ROUTE. The bottom route shall be installed first as shown in Figure 6-2, then the top route as shown in Figure 6-4 with the top route conductor bottoming on the bottom route conductor.

6. SIDE AND BOTTOM ROUTE. The bottom route shall be installed first as shown in Figure 6-2, then the side route as shown in Figure 6-3.

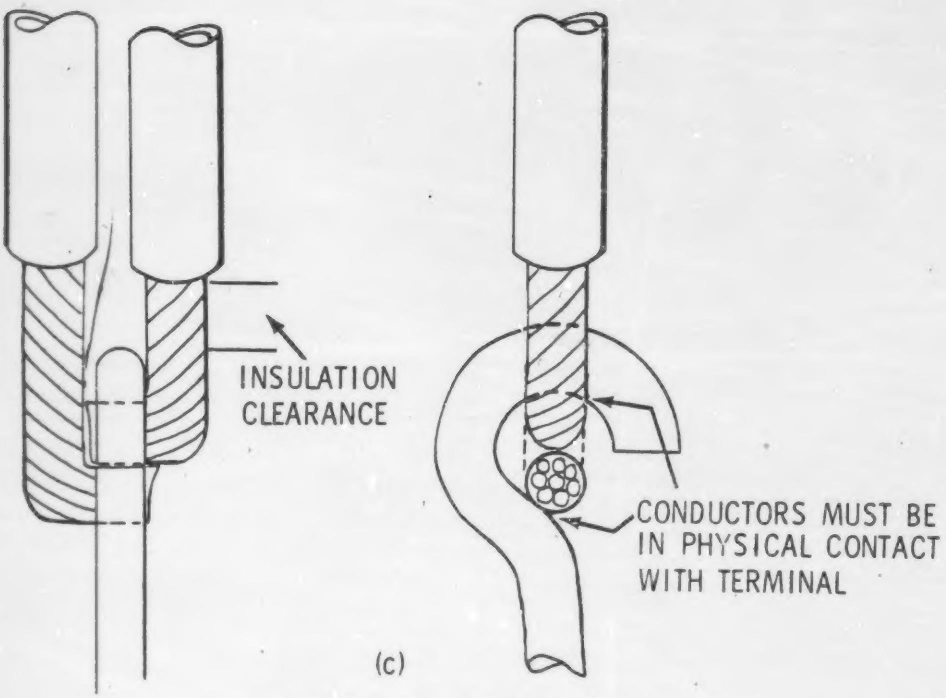
3A604 HOOK TERMINALS

Connections to hook terminals shall be as shown in Figure 6-5. The bend to attach conductors to hook terminals shall be a minimum of 1/4 turn to a maximum of 3/4 turn. Protrusion of conductor


INSULATION CLEARANCE
PROTRUSION
INSULATION CLEARANCE

(a) SINGLE CONDUCTOR

(b) MULTIPLE WIRE (PREFERRED)


INSULATION CLEARANCE
CONDUCTORS MUST BE IN PHYSICAL CONTACT WITH TERMINAL

(c)

MULTIPLE CONDUCTOR,
PERMISSABLE ONLY WHERE
REQUIRED BY SPACE LIMITATIONS

FIGURE 6-5—CONNECTIONS TO HOOK TERMINAL

ends shall be limited to avoid damage to insulation sleeving where used.

3A605 PIERCED TERMINALS

Connections to pierced terminals shall be as shown in Figure 6-6. The bend to attach conductors to pierced terminals shall be a minimum of 1/4 to a maximum of 3/4 turn. Protrusion of conductor ends shall be limited to avoid damage to insulation sleeving where used.

3A606 SOLDER CUPS (CONNECTOR TYPE)

Conductors shall enter the solder cup as shown in Figure 6-7. Conductors shall be bottomed in the cup and shall be in contact with the inner wall of the cup. The maximum number of conductors shall be limited to those which can be in contact with the full height of the inner wall of the cup.

3A607 SOLDER CUPS (SWAGED TYPE)

Connection shall be as shown in Figure 6-8. Conductors entering from the top shall be in contact with the inner wall of the cup and shall bottom in the cup or on the bottom conductor.

3A608 CONNECTION WITHOUT TERMINALS

When solid conductors are approved by NASA to be used as straight pin type terminals, conductors shall be terminated as specified in paragraph 3A602.

3A609 LAP JOINTS

A lap joint may be used for attaching conductors only where space does not allow room for bending the conductor, and the application has been reviewed by the procuring NASA Installation.

3A610 INSULATION TUBING APPLICATION

Insulation tubing shall be used for electrical insulation, as appropriate; for example, hook terminals and solder cups which are not protected by insulating grommets, potting or conformal coating.

901

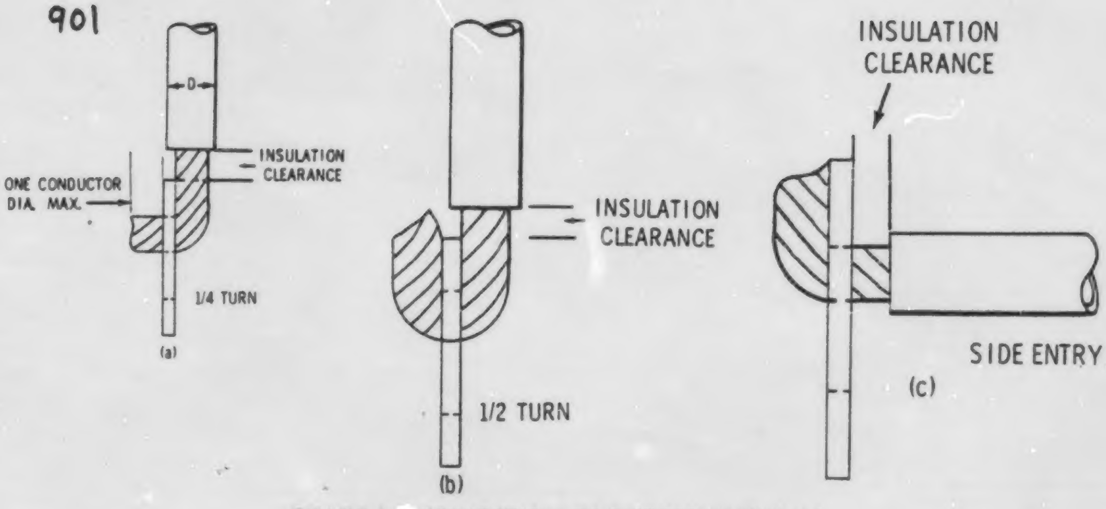

INSULATION CLEARANCE
D
ONE CONDUCTOR DIA. MAX.
1/4 TURN
(a)
INSULATION CLEARANCE
1/2 TURN
(b)
INSULATION CLEARANCE
SIDE ENTRY
(c)

FIGURE 6-6--CONNECTIONS TO PIERCED TERMINALS

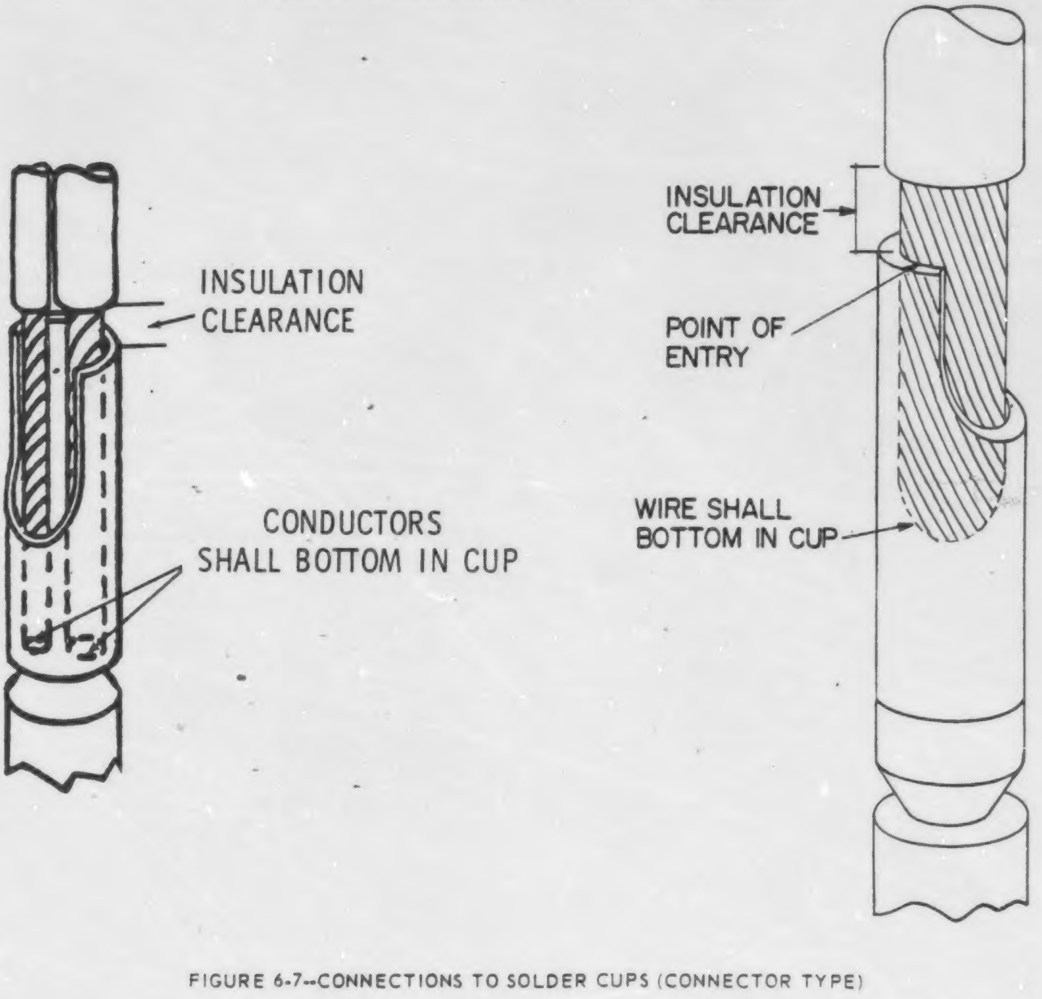
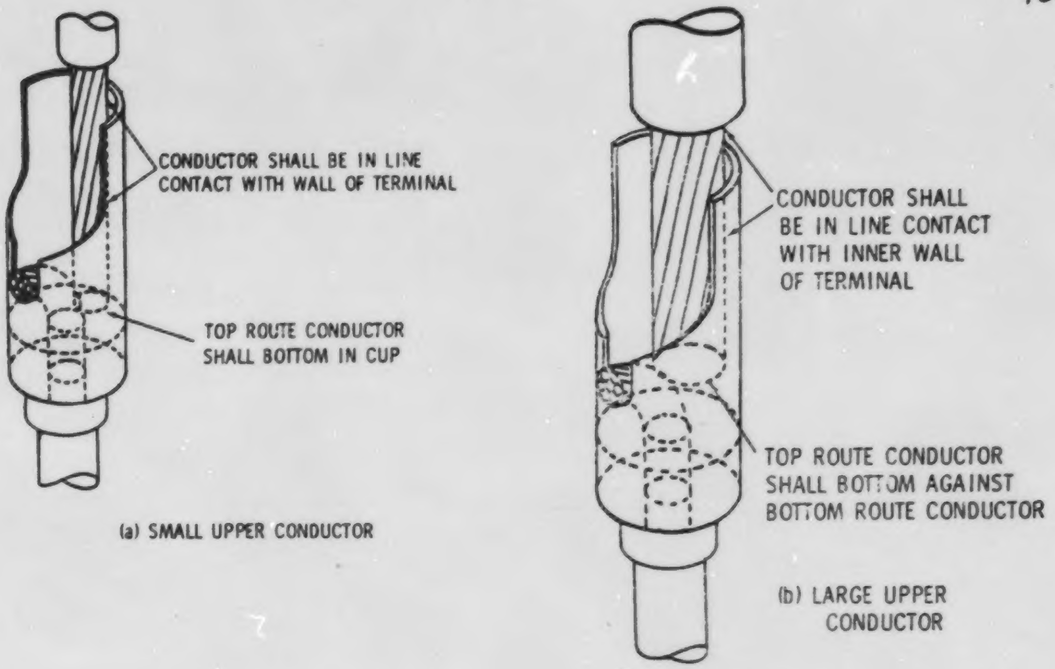
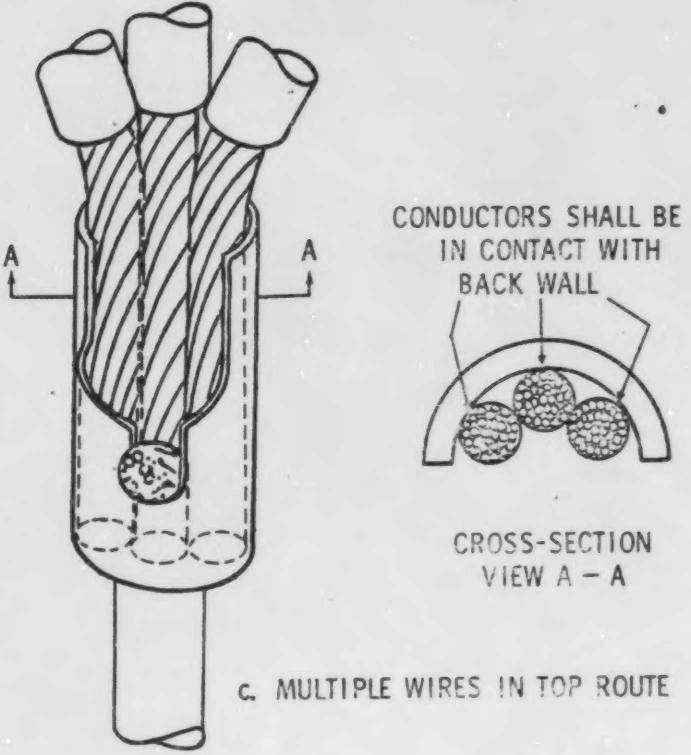

INSULATION CLEARANCE
CONDUCTORS SHALL BOTTOM IN CUP
INSULATION CLEARANCE
POINT OF ENTRY
WIRE SHALL BOTTOM IN CUP

FIGURE 6-7--CONNECTIONS TO SOLDER CUPS (CONNECTOR TYPE)


CONDUCTOR SHALL BE IN LINE CONTACT WITH WALL OF TERMINAL
TOP ROUTE CONDUCTOR SHALL BOTTOM IN CUP
CONDUCTOR SHALL BE IN LINE CONTACT WITH INNER WALL OF TERMINAL
TOP ROUTE CONDUCTOR SHALL BOTTOM AGAINST BOTTOM ROUTE CONDUCTOR

(a) SMALL UPPER CONDUCTOR

(b) LARGE UPPER CONDUCTOR


A
A
CONDUCTORS SHALL BE IN CONTACT WITH BACK WALL
CROSS-SECTION VIEW A – A

c. MULTIPLE WIRES IN TOP ROUTE

FIGURE 6-8--CONNECTIONS TO SWAGED TYPE SOLDER CUPS

903

CHAPTER 7: SOLDERING OF TERMINALS

3A700 GENERAL

1. SECURING CONDUCTORS. There shall be no relative motion between conductors and the terminal during soldering and while the solder is solidifying.

2. INSULATION SLEEVING, POTTING OR COATING. Protective coverings or coatings on the soldered terminals shall comply with requirements of the contract or purchase order.

3A701 SOLDER APPLICATION

1. SWAGED TERMINALS. Terminals swaged to a solid flat conductor shall be soldered to one surface of the conductor.

2. ALL TERMINALS EXCEPT CUP

   a. A concave fillet of solder shall be formed between the terminal and each side of the conductor.

   b. The contour of the conductor shall be visible after soldering.

   c. Terminals with more than one wire shall have each wire in contact with and soldered to the terminal.

3. CUP TERMINALS

   a. The solder shall form a fillet between the conductor and the cup entry slot. The fillet shall follow the contour of the cup opening within the limits illustrated in the satisfactory solder connections, Appendix B.

   b. Solder spillage along the outside surface of the solder cup is permissible to the extent that it approximates tinning and does not interfere with the assembly or function of the connector.

4. WICKING. Flow of solder along the wire is permitted. Solder shall not obscure the contour of the conductor at the termination of the insulation.

3A702 REMOVAL OF FLUX AND RESIDUE

After the solder has solidified and cooled, flux and residue shall be carefully removed from each solder connection using a solvent as specified in paragraph 3A311.

3A703 INSPECTION

Each soldered connection shall be visually inspected in accordance with the criteria of this chapter. Magnification shall be as specified by the procuring NASA Installation. Parts and conductors shall not be physically disturbed to aid inspection. Illustrations of typical satisfactory and unsatisfactory soldered connections are shown in Appendix B.

3A704 ACCEPTANCE CRITERIA

An acceptable solder connection will be characterized by:

1. Clean, smooth, undisturbed surface.
2. Concave fillet between conductor and termination.
3. Contour of conductor visible.
4. Complete wetting.

3A705 REJECTION CRITERIA

The following are some characteristics of unsatisfactory solder conditions which are cause for rejection:

1. CONDUCTORS AND PARTS:
    a. Damaged, crushed, cracked, charred, melted, etc.
    b. Improper insulation clearance.
    c. Improper tinning.
    d. Separation of wire strands.
    e. Part improperly supported or positioned.
    f. Part marking not visible.
    g. Part damaged.
    h. Loose conductors.
    i. Cut, nicked, stretched or scraped leads or wires.
    j. Flux residue or other contamination.
    k. Improper wrap or stress relief.

2. SOLDER CONNECTIONS:

   a. Cold joint.

   b. Overheated joint.

   c. Fractured joint.

   d. Bare copper or base metal.

   e. Improperly bonded joint.

   f. Pitted or porous joint.

   g. Excessive solder.

   h. Insufficient solder.

   i. Splattering of flux or solder or adjacent areas.

   j. Rosin solder connection.

   k. Unclean connection (e.g., lint, flux, dirt, etc.).

   l. Dewetting.

CHAPTER 8: PRINTED WIRING ASSEMBLY SOLDERING

3A800 FABRICATION AND CONFORMAL COATING

Printed wiring boards shall be designed, fabricated, and inspected in accordance with the requirements of the contract or purchase order. The assembly of parts, soldering and inspection of the completed wiring assemblies shall be in accordance with the requirements herein.

3A801 GENERAL REQUIREMENTS

1. DIP SOLDERING. Manual dip soldering of printed wiring assemblies is not permitted.

2. PATTERN REPAIR. Repair of damaged or broken conductor patterns on printed wiring boards is not permitted.

3. MACHINE SOLDER REWORK. Rework of machine soldered printed wiring assemblies shall be performed in accordance with the soldering requirements of this publication.

4. GOLD REMOVAL. Gold plating shall be removed from the printed board areas to be soldered prior to mounting of parts. Removal shall not damage the copper conductor or add permanent contaminants to the insulating board. Boards shall be cleaned of contaminants before further processing.

5. EYELETS, TUBELETS AND PLATED-THROUGH HOLES. Eyelets or tubelets shall not be used as part of the electrical circuit on printed wiring boards. Plated-through holes shall not be used unaided as the electrical connection between conductor patterns on double-sided boards. A solid copper conductor, or a part lead, shall be used to make the interfacial electrical connection.

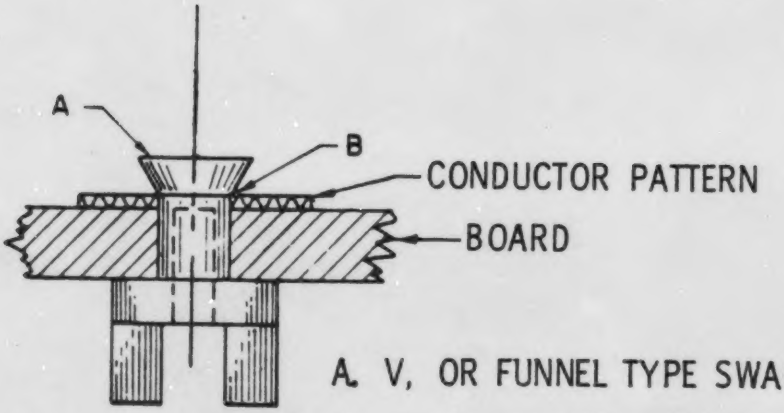
3A802 PRINTED WIRING BOARD PROTECTION

Printed wiring boards shall be protected to prevent damage or contamination during fabrication, inspection, in-plant transportation, and interim storage.

3A803 TERMINAL SOLDERING

Terminals swaged to conductor patterns shall be funnel swaged ("V" swaged) and soldered at all points of contact between the terminal and the conductor pattern. Roll type swaging shall not be used on the conductor pattern (see Figure 8-1). Terminals shall not be used for interfacial connection.

907



A. V, OR FUNNEL TYPE SWAGE.

B. POINT TO APPLY SOLDER IF SOLDER RING IS NOT USED.

FIGURE 8-1--TYPICAL SWAGED TERMINAL ON PRINTED WIRING BOARD

3A804 PREPARATION AND SOLDERING OF TERMINATION AREAS

1. TERMINATION AREA. The termination area shall be clean prio to soldering. Soldering to printed wiring termination areas shal be to the base metal or to tin-lead coated base metal.

2. SOLDERING TO TERMINATION AREAS. The melted solder shal flow around the conductor and over the termination area so that fillet is formed. The outline of the lead shall be visible in th finished connection. After soldering, flux residue and other contaminants shall be removed.

3A805 INSPECTION

Each completed printed wiring assembly shall be visually inspecte to the criteria listed in paragraphs 3A806 and 3A807 and for othe indications of poor workmanship or nonconformance to the desig drawings. Magnification shall be as specified by the procuring NAS Installation.

3A806 ACCEPTANCE CRITERIA

The following are characteristics of acceptable solder connection to printed wiring assemblies:

1. Clean, smooth, undisturbed surface.
2. Regular, even fillet between conductor and termination area.
3. Contour of conductor visible.
4. Complete wetting.

3A807 REJECTION CRITERIA

The following are some characteristics of unsatisfactory printed wiring assemblies which are cause for rejection:

1. Charred, burned, or melted insulation or parts.
2. Conductor pattern separation from board.
3. Burns on base materials.
4. Discoloration which is continuous between conductors (e.g., measling, delamination, halo effect, etc.)
5. Excessive solder (including peaks, icicles, and bridging).
6. Flux residue, solder splatter, or other foreign matter.
7. Dewetting.
8. Insufficient solder (a small amount of exposed base metal around the periphery of the termination area or at the end of a conductor is acceptable if conformal coating will be applied).
9. Pits, holes or voids, or exposed base metal in the soldered connection.
10. Cold, rosin, disturbed, or fractured solder connection.
11. Cut, nicked, gouged, or scraped conductors or conductor pattern.
12. Improper conductor length or direction of clinch.
13. Repaired or damaged conductor pattern.

CHAPTER 9: AUTOMATIC MACHINE SOLDERING

3A900 GENERAL

This chapter contains requirements peculiar to automatic machine soldering. General requirements including acceptance and rejection criteria specified in this publication are applicable.

3A901 DOCUMENTATION

1. The supplier shall estabish complete and detailed documentation for operation and maintenance of the soldering machines and their environment, and for inspection of both the process and the end-products.

2. The documentation shall set limits on the:

   a. Preheat temperature,

   b. Temperature of the solder,

   c. Conveyor speed,

   d. Height of the solder wave,

   e. Control of the dross inhibition oil and flux (if fluxing is done as a machine step),

   f. Amount of contaminants permissible when the solder bath is analyzed,

   g. Frequency of maintenance and of analysis and other factors affecting the quality of the connections in the end-product,

   Maintenance and calibration data shall be recorded and available to Government and supplier inspection.

3A902 PREPARATION AND ASSEMBLY

1. Only tin-lead (solder) coated and reflowed electro-plated tin-lead coated conductor patterns shall be used in machine soldering of printed wiring board assemblies.

2. Parts shall be mounted as specified in Chapters 5 and 6 of this document. The mounting shall prevent relative motion between part and board during solder solidification.

3. The assembled boards shall be clean immediately prior to loading on to the carrier.

4. Metal surfaces not to be soldered shall be masked or coated with a solder resist prior to loading.

5. Liquid flux specified in paragraph 3A310 shall be applied.

3A903 MACHINE REQUIREMENTS

1. The preheat temperature shall be controlled to a selected temperature between 160° and 180° F. The selected temperature shall be maintained within ± 5° F.

2. The conveyer speed shall be controlled to a preselected rate, which shall not vary more than 1 inch per minute.

3. Solder temperature shall be controlled so that the solder in the wave making contact with the board is 490° F ± 10° F.

4. The oil used as a dross inhibitor shall have a flash point higher than the maximum solder temperature.

5. The height of the solder wave shall be controlled to a constant preselected height.

6. The solder bath shall be chemically analyzed periodically for conformance with the requirements of paragraph 3A309 except that copper content shall not exceed 0.2%.

3A904 CLEANING

After soldering, flux and dross inhibitor oil shall be promptly removed in a manner which does not damage the hardware.

3A905 INSPECTION

Inspection criteria listed in Chapter 8 are applicable to machine soldered assemblies. Warp or twist of the board shall not exceed the limits specified by the detail drawing.

APPENDIX A

DEFINITIONS

The following definitions apply to terms used in this Handbook.

Article. A unit of hardware or any portion thereof required by the contract.

Bifurcated (split) Terminal. A terminal containing a slot or split in which wires or leads are placed before soldering.

Certification. The act of competent authority in verifying and documenting that personnel have completed required training and have demonstrated specified proficiency and have met other specified requirements.

Cold Solder Connection. Unsatisfactory connection resulting from dewetting and exhibiting an abrupt rise of the solder from the surface being soldered.

Conduction Soldering. Method of soldering which employs a soldering iron for transfer of heat to the soldering area.

Conductor. A lead or wire, solid or stranded, serving as an electrical connection between terminals.

Conformal Coating. A thin protective coating which conforms to the configuration of the covered assembly.

Cordwood Construction. Circuitry in which parts are mounted between, and perpendicular to, two printed wiring or conductive networks.

Deviation. A specific authorization, granted before the fact, to depart from a particular requirement of specifications or related documents.

Dewetting. The condition in a soldered area in which the liquid solder has not adhered intimately, characterized by an abrupt boundary between solder and conductor, or solder and terminal/termination area.

Disturbed Solder Connection. Unsatisfactory connection resulting from relative motion between the conductor and termination during solidification of the solder.

Electrical Connection. Connections in electrical or electronic circuits.

Excessive Solder Connection. Unsatisfactory connection wherein the solder obscures the configuration of the connection.

Eyelet. A tubular metal part having both ends headed or rolled over.

Fractured Joint. A solder joint in which the solder has fractured or broken between the joint elements.

Hook Terminal. A terminal formed in a hook shape.

Mission Essential Support Equipment. Mission-essential support equipment is defined as satisfying any of the following:

1. Equipment used in a closed loop with the system where failure would degrade the mission or imperil personnel.
2. Equipment used when transferring toxic or explosive fluids, in which failure could result in personnel hazards or affect mission success.
3. Equipment used as a last check prior to installation whose failure would result in lowering the probability of mission success or compromising personnel safety.

Part Lead. The wire, solid or stranded, which extends from and serves as a connection to a part.

Part. One piece, or two or more pieces joined together which are not normally subject to disassembly without destruction of designed use. Synonomous with detail part and component part (e.g. resistor, capacitator, valve, relay).

Potting Compound. A nonconductive compound used for encapsulation of parts, conductors or assemblies.

Pierced (Perforated) Terminal. A terminal containing a hole through which leads or wires are placed before soldering.

Pits. Small holes or sharp depressions in the surface of the solder.

Repair. Operations performed on a nonconforming article to place it in useable and acceptable condition. Repair is distinguished from rework.

Resistance Soldering. Method of soldering, by passing a current between two electrodes through the area to be soldered.

913

Rework. The reprocessing of articles or material that will make it conform to drawings, specification or contract.

Rosin Solder Connection. Unsatisfactory connection which has trapped flux.

Overheated Joint. An unsatisfactory solder joint, characterized by rough solder surface.

Solder. A nonferrous, fusible metallic alloy used when melted to join metallic surfaces.

Solder Cup Terminal. A hollow, cylindrical terminal to accommodate one or more conductors.

Soldering. The process of joining metallic surfaces through the use of solder without direct fusion of the base metals.

Straight Pin Terminal. A round post-type smooth terminal, with no grooves, slots, or guides.

Supplier. A contractor or subcontractor actually performing the services or producing the contract articles.

Terminal. A tie point device used for making electrical connections.

Termination. The point at which an electrical conductor ends, usually at an electrical connection.

Termination Area. A conductive surface on a printed wiring board used for making electrical connections. (Also referred to as printed circuit pad).

Thermal Shunt. A device with good heat dissipation characteristics used to conduct heat away from an article being soldered.

Tinning. The coating of a surface with a uniform layer of solder, before it is used in a soldered connection.

Tubelet. A tubular metal part with both ends formed in a conical flare of approximately 90 degrees included angle.

Turret Terminal. A round post-type grooved stud around which conductors are fastened before soldering.

Waiver. Granted use, or acceptance, of an article which does not meet specified requirements.

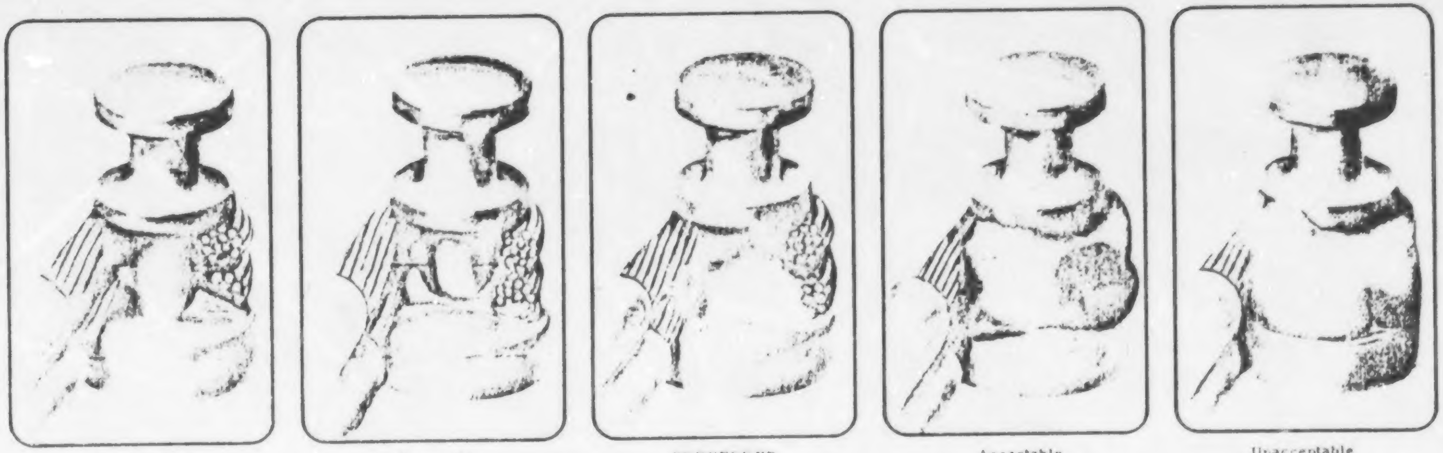
Wetting. Adhesion of a liquid to a solid surface.

Wicking. The flow of molten solder by capillary action.

APPENDIX B

TYPICAL SATISFACTORY AND UNSATISFACTORY SOLDER CONNECTIONS

The Illustrations in this Appendix depict typical satisfactory and unsatisfactory solder connections and are to be used as visual workmanship standards. See paragraphs 3A703, 3A805 and 3A905.



Unacceptable Insufficient Solder

Acceptable Minimum Solder

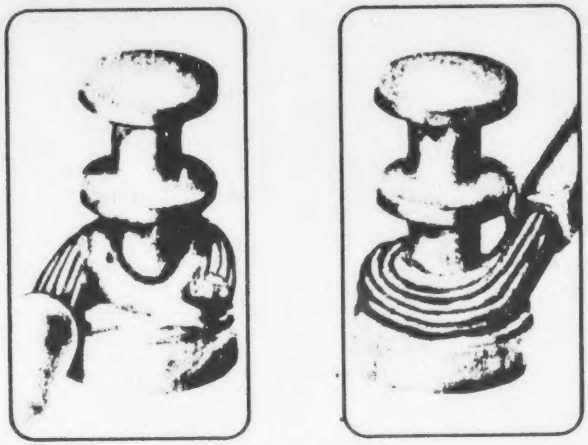
PREFERRED SOLDER

Acceptable Maximum Solder

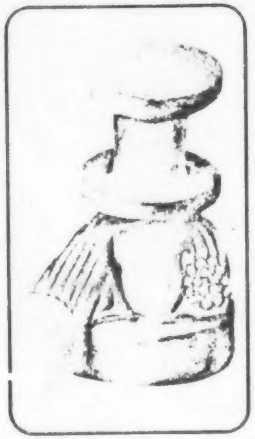
Unacceptable Excessive Solder

FIGURE B-1--SOLDERED TURRET TERMINALS

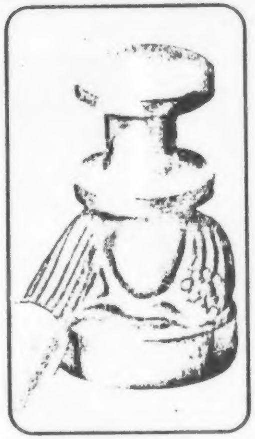
FIGURE B-1--SOLDERED TURRET TERMINALS--Con.



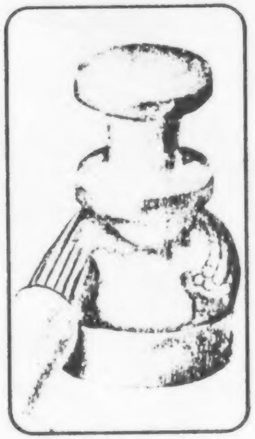
PREFERRED SOLDER



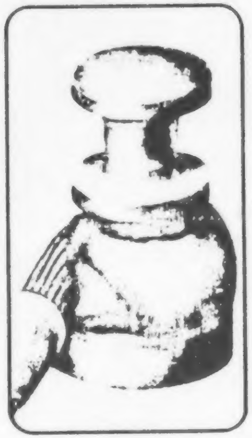
Unacceptable
Insufficient
Solder



Acceptable
Minimum
Solder



Acceptable
Maximum
Solder



Unacceptable
Excessive
Solder

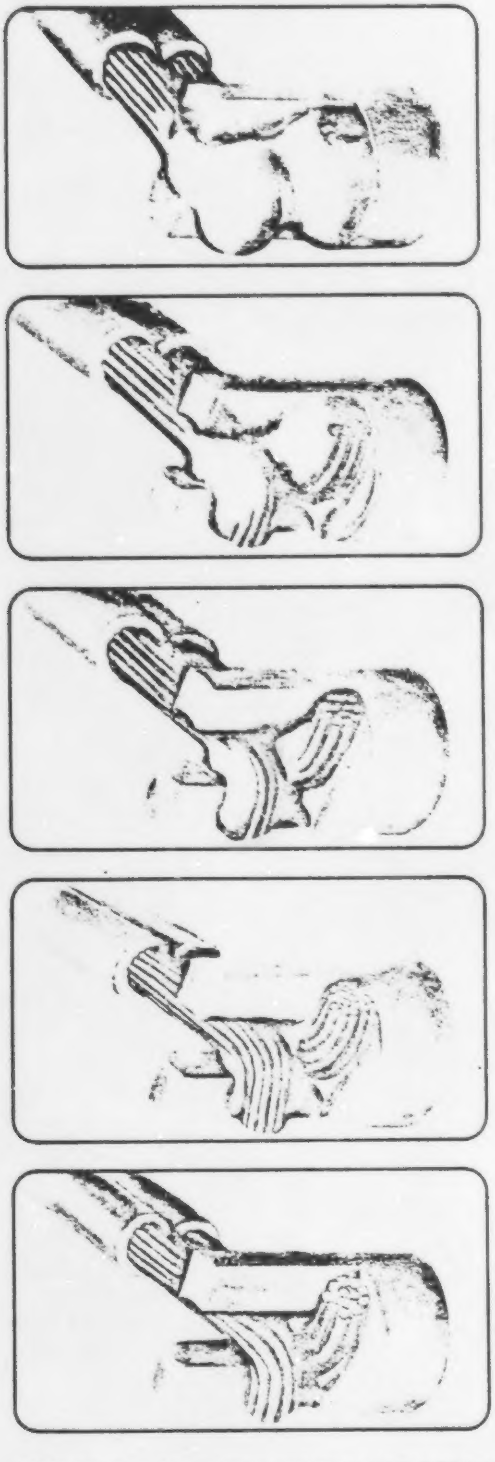
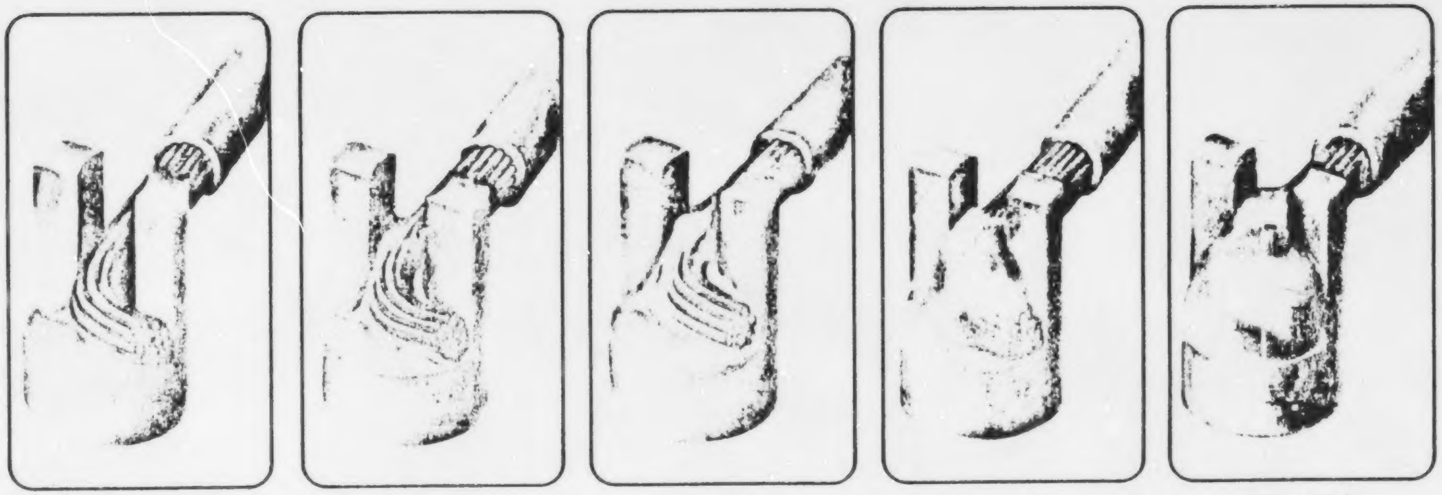

Unacceptable Excessive Solder
Acceptable Maximum Solder
PREFERRED SOLDER
Acceptable Minimum Solder
Unacceptable Insufficient Solder

FIGURE B-2--SOLDERED BIFURCATED TERMINALS



Unacceptable Insufficient Solder

Acceptable Minimum Solder

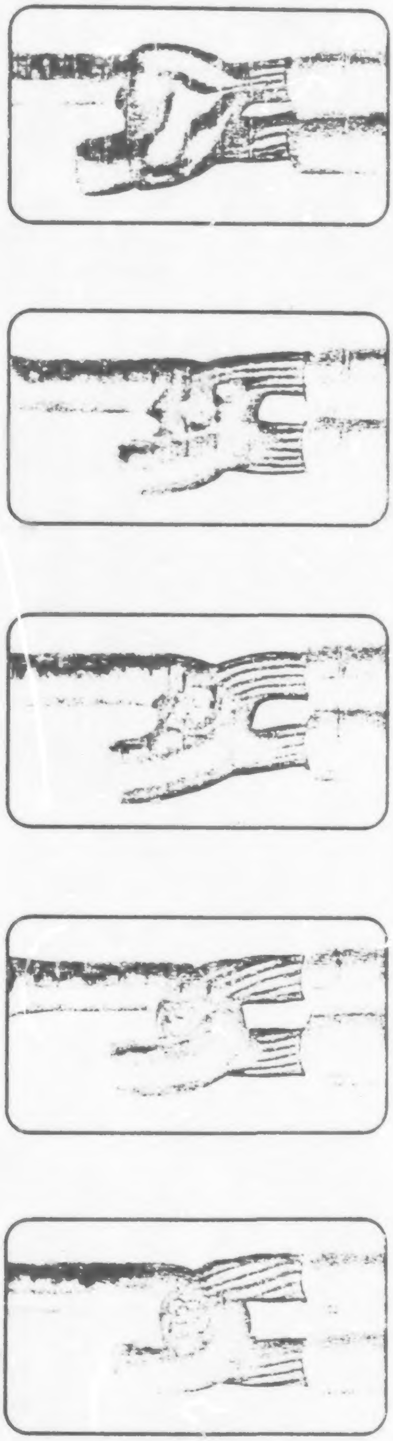
PREFERRED SOLDER

Acceptable Maximum Solder

Unacceptable Excessive Solder

FIGURE B-2--SOLDERED BIFURCATED TERMINALS--Con.

918



Unacceptable
Insufficient
Solder

Acceptable
Minimum
Solder

PREFERRED
SOLDER

Acceptable
Maximum
Solder

Unacceptable
Maximum
Solder

FIGURE B-3--SOLDERED HOOK TERMINALS

1602

1601

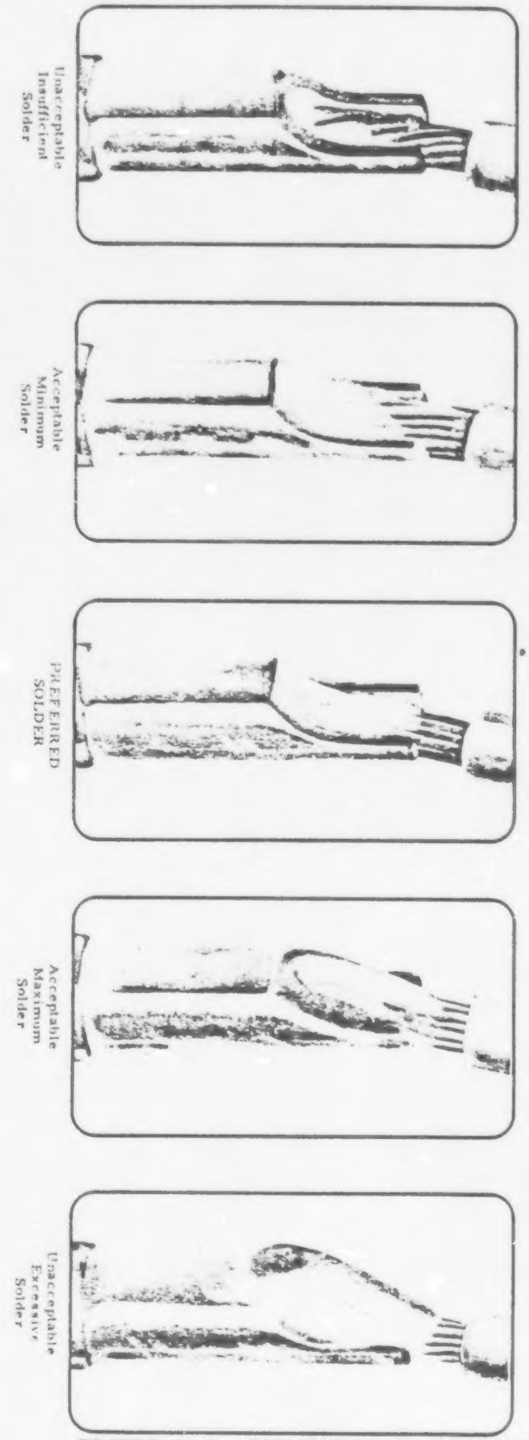
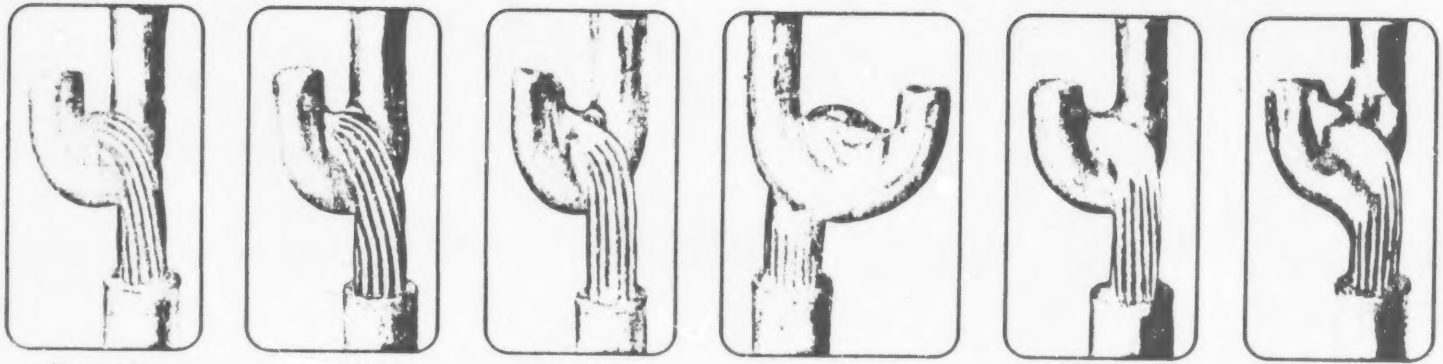

Unacceptable
Insufficient
Solder
Acceptable
Minimum
Solder
PREFERRED
SOLDER
Acceptable
Maximum
Solder
Unacceptable
Excessive
Solder

FIGURE B-4--SOLDERED CUP TERMINALS



Unacceptable Insufficient Solder

Acceptable Minimum Solder

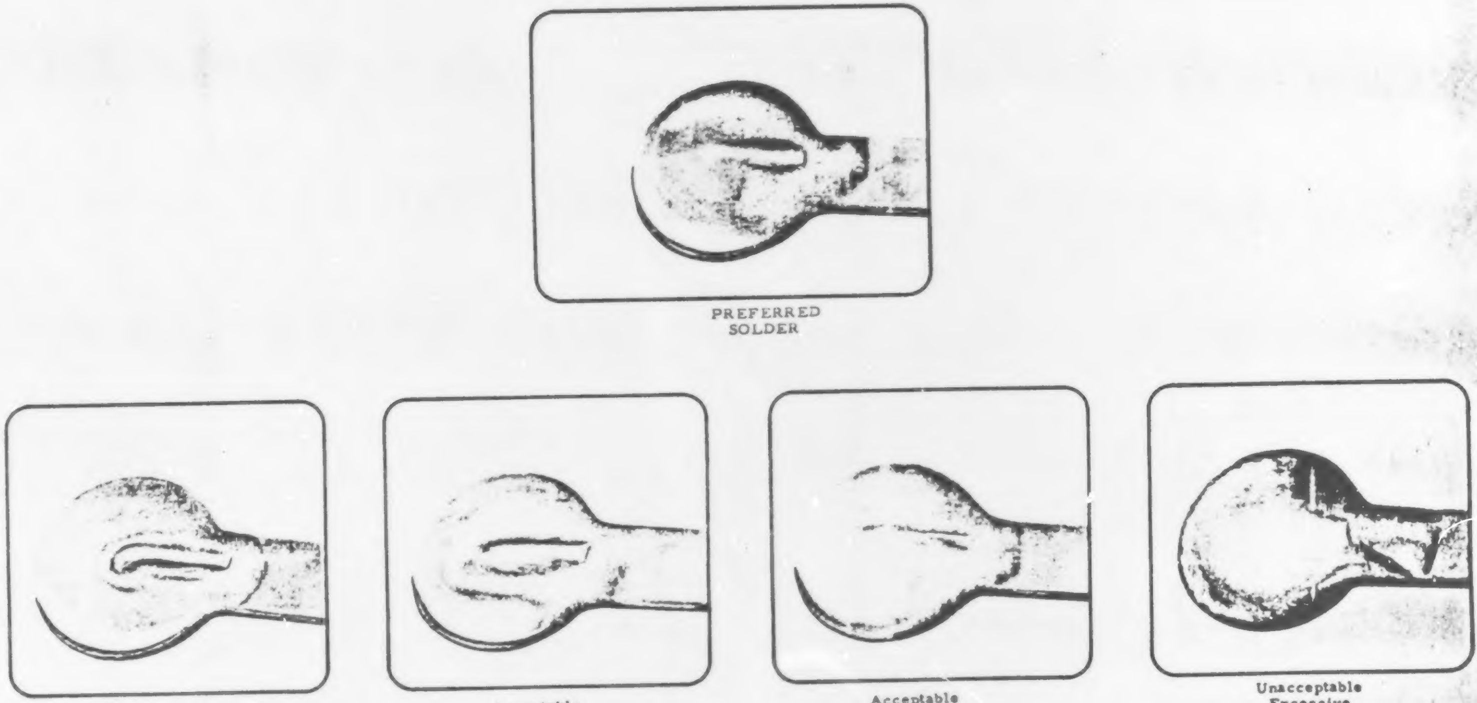
PREFERRED SOLDER

PREFERRED SOLDER

Acceptable Maximum Solder

Unacceptable Excessive Solder

FIGURE B-3--SOLDERED HOOK TERMINALS--Con.



PREFERRED
SOLDER

Unacceptable
Insufficient
Solder

Acceptable
Minimum
Solder

Acceptable
Maximum
Solder

Unacceptable
Excessive
Solder

FIGURE B-5--SOLDERED PRINTED WIRING AREAS

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922

MINIATURE/MICROMINIATURE ELECTRONIC REPAIR (2M) PROGRAM
PERFORMANCE TEST BOOKLET

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 2-1

PRINTED CIRCUIT BOARD COMPONENT INSTALLATION AND SOLDERING

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Install and solder a minimum of ten (10) various components on a selected single sided printed circuit board using preferred mounting styles and terminations with high reliability soldering techniques meeting or exceeding all specifications illustrated in MIL-S-45743E and described in Notetaking Sheet 2-1-1N.

B. Install and solder a minimum of six (6) various components on a selected double sided printed circuit board using any of the preferred mounting styles and terminations with high reliability soldering techniques meeting or exceeding all specifications illustrated in MIL-S-45743E and described in Notetaking Sheet 2-1-1N.

II. PERFORMANCE:

A. Position a minimum of ten (10) instructor selected components, shape their leads and mount them on a single sided printed circuit board using the following styles and terminations, utilizing the high reliability soldering techniques illustrated in MIL-S-45743E and described in Notetaking Sheet 2-1-1N.

1. Two (2) components with flush mounting and semi-clinch terminations.
2. Two (2) components with flush mounting and straight thru terminations.
3. Two (2) components with flush mounting and full clinch terminations.
4. Two (2) components with stress relief mounting and straight thru terminations.
5. Two (2) components with vertical mounting and straight thru terminations.

924

B. Position a minimum of six (6) instructor selected components, shape their leads and mount them on a double sided printed circuit board using any of the preferred mounting styles, terminations and high reliability soldering techniques illustrated in MIL-S-45743E and described in Notetaking Sheet 2-1-1N.

NOTE: Circuit boards may be presented at any time for informal evaluation on work being performed prior to grading. Constructive comments by the instructor on component installation and soldering technique will be offered as information.

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in the completed boards with the minimum amount of components installed for grading by the seventh day of the course. Quality of completed work must meet the acceptable standards as illustrated in MIL-S-45743E and described in Notetaking Sheet 2-1-1N for a satisfactory (SAT) completion. If either or both of the boards are determined to be unsatisfactory (UNSAT), the student will be allowed to rework and resubmit them for grading, by the ninth day. Two UNSAT's on the same tasks will be cause for convening an academic board and possible drop from the course.

IV. EQUIPMENT:

A. One 2M kit
B. One single sided printed circuit board
C. One double sided printed circuit board
D. A minimum of sixteen (16) component parts
E. Comsumable supplies as necessary.

1610

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 2-2

CONFORMAL COATING REMOVAL

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Identify the types of conformal coatings on printed circuit boards and determine the proper method of removal to be used for each coating, based on information contained in Volume 6 of PACE Rework and Repair Technology Series and Notetaking Sheet 2-2-1N.

B. Remove various conformal coatings from printed circuit boards using the chemical, heat and abrasive methods of removal and the proper tools necessary as outlined in Volume 6 of the PACE Rework and Repair Technology Series and Notetaking Sheet 2-2-1N.

II. PERFORMANCE:

A. Identify the conformal coating on a minimum of three instructor provided printed circuit boards, without error, and determine which method of removal is to be used. Identification and determination will be in concurrence with the information provided in Notetaking Sheet 2-2-1N and Information Sheet 2-2-1I.

B. Remove a minimum of one designated component from each coated printed circuit board using the chemical, heat and/or abrasive methods of removal as described in Volume 6 of the PACE Rework and Repair Technology Series and Notetaking Sheet 2-2-1N, with no damage or degradation to the components or printed circuit boards.

NOTE: Circuit boards used for Conformal Coating Removal may be presented at any time for informal evaluation on work being performed prior to grading. Constructive comments by the instructor on identification and coating removal will be offered as information.

926

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in the three circuit boards with the correct identification and specified components removed for grading by the seventh day of the course. Removal of coated components must be performed with no damage or degradation to the components or circuit boards to receive a satisfactory (SAT) grade. If the components removal is determined to be unsatisfactory (UNSAT), the student will be permitted to rework and resubmit them for grading, by the ninth day. Two UNSAT's on the same task will be cause for convening an academic board and possible drop from the course.

IV. EQUIPMENT:

A. One 2M kit
B. Three selected printed circuit boards with a different type conformal coating on each
C. Consumable supplies as necessary

1612

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 2-3

DESOLDERING PRINTED CIRCUIT BOARD COMPONENTS

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Identify the various types of solder connections by visual inspection of selected single and double sided printed circuit boards, evaluate the task to be performed and determine the proper desoldering and component removal method to be used. Identification, evaluation and determination will be based on information contained in Volume 6 of the PACE Rework and Repair Technology Series and Notetaking Sheet 2-3-1N.

B. Remove components from selected printed circuit boards using the wicking, manual and motorized solder extraction methods of desoldering as described in Volume 6 of the PACE Rework and Repair Technology Series and Notetaking Sheet 2-3-1N, with minimum damage or degradation to the components and/or circuit boards.

II. PERFORMANCE:

A. Remove a minimum of four (4) selected components from an instructor provided single sided printed circuit board using the wicking method of desoldering, in accordance with procedures and to the damage and degradation standards outlined in Volume 6 of the PACE Series and Notetaking Sheet 2-3-1N.

B. Remove a minimum of four (4) selected components from an instructor provided double sided printed circuit board using the manual vacuum method of desoldering in accordance with the procedures and to the damage and degradation standards outlined in Volume 6 of the PACE Series and Notetaking Sheet 2-3-1N.

C. Remove a minimum of four (4) selected components from an instructor provided double sided printed circuit board using the motorized extractor method of desoldering, in accordance with the procedures and to the damage and degradation standards outlined in Volume 6 of the PACE Series and Notetaking Sheet 2-3-1N.

NOTE: Circuit boards may be presented at any time for informal evaluation on work being performed prior to grading. Constructive comments by the instructor on component removal and desoldering technique will be offered as information.

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in three circuit boards with the minimum number of components removed from each, for grading by the seventh day of the course. Quality of completed work must meet the acceptable standards of no damage or degradation of components or circuit boards to receive a satisfactory (SAT) grade. If the desoldering and component removal is determined to be unsatisfactory (UNSAT), the student will be permitted to rework and resubmit them for grading by the ninth day. Two UNSAT's on the same task will be cause for convening an academic board and possible drop from the course.

IV. EQUIPMENT:

A. One 2M kit
B. One selected single sided printed circuit board
C. Two selected double sided printed circuit boards
D. Consumable supplies as necessary

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 2-4

REPAIR OF DAMAGED PRINTED CIRCUIT BOARDS

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Identify the four categories of damage common to printed circuit boards. Identification will be in concurrence with information contained in Notetaking Sheet 2-4-1N.

B. Determine the extent of repair required and the proper repair technique to be used on any printed circuit board in accordance with information outlined in Notetaking Sheet 2-4-1N and MIL-STD-454D.

C. Repair damaged printed circuit board conductors, eyelets and laminates using the proper tools and techniques and to the standards outlined in Notetaking Sheet 2-4-1N and MIL-STD-454D.

II. PERFORMANCE:

A. Repair the conductor damage on an instructor provided printed circuit board following the procedures and to the acceptable standards outlined in Notetaking Sheet 2-4-1N utilizing the high reliability soldering techniques illustrated in MIL-S-45743E. A minimum of one each of the following type conductor repairs is required:

1. One (1) Flow repair
2. One (1) Lap repair
3. One (1) Clinch Staple repair
4. One (1) Pad replacement with an eyelet set in the pad repair

B. Perform a laminate repair of a burned area on an instructor provided printed circuit board using the Rebuilding technique and to the acceptable standards outlined in Notetaking Sheet 2-4-1N.

NOTE: Circuit boards may be presented at any time for informal evaluation on work being performed prior to grading. Constructive comments by the instructor on conductor and laminate repair techniques will be offered as information.

1615

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in the printed circuit boards with the required conductor repairs and laminate repair completed by the ninth day of the course. Quality of completed work must meet teh acceptable standards for printed circuit board repair as illustrated in MIL-S-45743E and outlined in Notetaking Sheet 2-4-1N to receive a satisfactory (SAT) grade. If the laminate or conductor repairs are determined to be unsatisfactory (UNSAT), the student will be permitted to rework and resubmit them for grading by the tenth day. Two UNSAT's will be cause for convening an academic board and possible drop form the course.

IV. EQUIPMENT:

A. One 2M kit
B. One printed circuit board with four conductors damaged
C. One printed circuit board with overheated laminated damage
D. Epoxy
E. Scrap circuit board or fiberglass powder
F. Copper Foil
G. Consumable supplies as necessary

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 3-1

HAND SOLDERING TURRET TERMINALS

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Connect properly prepared wires to prepared turret terminals, using preferred mounting styles and terminations, with high reliability soldering techniques meeting or exceeding all specifications illustrated in MIL-S-45743E and described in Notetaking Sheet 3-1-1N.

II. PERFORMANCE:

A. Complete a minimum of two (2) single entry turret terminal connections, after preparing the wires and terminals, using the preferred mounting styles and high reliability soldering techniques illustrated in MIL-S-45743E and described in Notetaking Sheet 3-1-1N.

B. Complete a minimum of one (1) double entry turret terminal connection, after preparing the wires and terminal, using the preferred mounting style and high reliability soldering techniques illustrated in MIL-S-45743E and described in Notetaking Sheet 3-1-1N.

NOTE: Turret terminals may be presented at any time for informal evaluation on work being performed prior to grading. Constructive comments by the instructor on turret terminal connection techniques will be offered as information.

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in a minimum of two single entry and one double entry turret terminal connections for grading by the ninth day of the course. Quality of completed work must meet the acceptable standards for turret terminal connections as illustrated in MIL-S-45743E and described in Notetaking Sheet 3-1-1N to receive a satisfactory (SAT) completion grade. If either or both of the connection styles are determined to rework and resubmit them for grading by the tenth day. Two UNSAT's on the same task will be cause for convening an academic board and possible drop from the course.

IV. EQUIPMENT:

A. One 2M kit
B. Turret Terminals
C. Wire
D. Consumable supplies as necessary

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 3-2

HAND SOLDERING HOOK AND PIERCED TAB TERMINALS

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Connect properly prepared wires to prepared hook and pierced tab terminals, using preferred mounting styles and terminations, with high reliability soldering techniques meeting or exceeding all specifications illustrated in MIL-S-45743E and described in Notetaking Sheet 3-2-1N.

II. PERFORMANCE:

A. Complete a minimum of two (2) single entry and one (1) double entry hook terminal connections, after preparing the wires and terminals, using the preferred mounting styles and high reliability soldering techniques illustrated in MIL-S-45743E and described in Notetaking Sheet 3-2-1N.

B. Complete a minimum of two (2) single entry and one (1) double entry pierced tab terminal connections, after preparing the wires and terminals, using the preferred mounting styles and high reliability soldering techniques illustrated in MIL-S-45743E and described in Notetaking Sheet 3-2-1N.

NOTE: Hook and pierced tab terminals may be presented at any time for informal evaluation of work being performed prior to grading. Constructive comments by the instructor on hook and pierced tab terminal connections techniques will be offered as information.

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in the specified minimum single and double entry hook and pierced tab terminal connections for grading by the ninth day of the course. Quality of completed work must meet the acceptable standards for the terminal connections as illustrated in MIL-S-45743E and described in Notetaking Sheet 3-2-1N to receive a satisfactory (SAT) completion grade. If any of the connections styles are determined to be unsatisfactory (UNSAT) the student will be permitted to rework and resubmit them for grading by the tenth day. Two UNSAT's on the same task will be the cause for convening an academic board and possible drop from the course.

IV. EQUIPMENT:

A. One 2M kit
B. Hook and Pierced Tab Terminals
C. Wire
D. Consumable supplies as necessary

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 3-3

HAND SOLDERING BIFURCATED TERMINALS

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Connect properly prepared wires to prepared bifurcated terminals, using preferred mounting styles and terminations, with high reliability soldering techniques meeting or exceeding all specifications illustrated in MIL-S-45743E and described in Notetaking Sheet 3-3-1N.

II. PERFORMANCE:

A. Complete a minimum of one (1) each of the following bifurcated terminal connections, after preparing the wires and terminals, using the preferred mounting styles and high reliability soldering techniques illustrated in MIL-S-45743E and described in Notetaking Sheet 3-3-1N:

1. One (1) Single entry
2. One (1) Double entry
3. One (1) Top entry
4. One (1) Bottom entry

NOTE: Bifurcated terminals may be presented at any time for informal evaluation of work being performed prior to grading. Constructive comments by the instructor on bifurcated terminal connections techniques will be offered for information.

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in a minimum of one (1) single entry, one (1) double entry, one (1) top and one (1) bottom entry bifurcated terminal connections for grading by the tenth day of the course. Quality of completed work must meet the acceptable standards for bifurcated terminal connections as illustrated in MIL-S-45743E and described in Notetaking Sheet 3-3-1N to receive a satisfactory (SAT) completion grade. If any of the connections are determined to be unsatisfactory (UNSAT), the student will be permitted to rework and resubmit them for grading by the twelfth day. Two UNSAT's on the same task will be cause for convening an academic board and possible drop from the course.

IV. EQUIPMENT:

A. One 2M kit
B. Bifurcated terminals
C. Wire
D. Consumable supplies as necessary

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 3-4

HAND SOLDERING CONNECTOR PINS

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Connect properly prepared wires to prepared solderable connector pins using preferred mounting styles and terminations, with high reliability soldering techniques meeting or exceeding all specifications illustrated in MIL-S-45743E and described in Notetaking Sheet 3-4-1N.

II. PERFORMANCE:

A. Complete a minimum of five (5) single entry connector pin connections, after preparing the wires and connector pins, using preferred mounting styles and high reliability soldering techniques illustrated in MIL-S-45743E and described in Notetaking Sheet 3-4-1N.

NOTE: **Connector pins may be presented at any time for informal** evaluation on work being performed prior to grading. Constructive comments by the instructor on connector pin connection techniques will be offered as information.

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in a minimum of five (5) single entry connector pin connections for grading by the tenth day of the course. Quality of completed work must meet the acceptable standards for connector pin connections as illustrated in MIL-S-45743E and described in Notetaking Sheet 3-4-1N to receive a satisfactory (SAT) completion grade. If any connector pin connections are determined to be unsatisfactory (UNSAT), the student will be permitted to rework and resubmit them for grading by the twelfth day. Two UNSAT's on the same task will be cause for convening an academic board and possible drop from the course.

IV. EQUIPMENT:

A. One 2M kit
B. Connector pins
C. Wire
D. Consumable supplies as necessary

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 4.3

MICRO-ELECTRONIC CIRCUIT CONFORMAL COATING REMOVAL AND DESOLDERING TECHNIQUES

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Remove various conformal coatings from micro-electronic printed circuit boards using the heat, chemical and/or abrasive methods and the necessary tools as outlined in Volume 6 of the PACE Rework and Repair Technology Series and Notetaking Sheet 3-4-1N.

B. Remove various component parts from micro-electronic printed circuit boards using the correct tools and desoldering techniques as outlined in Volume 6 of the PACE Rework and Repair Technology Series and Notetaking Sheet 3-4-1N.

II. PERFORMANCE:

A. Remove a minimum of two (2) specific dual-in-line components (DIP'S), from an instructor selected conformal coated micro-electronic printed circuit board, using the correct micro conformal coating removal method and micro electronic desoldering techniques as outlined in Volume 6 of the PACE Rework and Repair Technology Series and the information contained in Notetaking Sheet 3-4-1N.

B. Remove a minimum of two (2) specific flat pack components (FLAT PACK's), from an instructor selected conformal coated micro-electronic printed circuit board, using the correct micro conformal coating removal method and micro electronic desoldering techniques as outlined in Volume 5 of the PACE Rework and Repair Technology Series and the information contained in Notetaking Sheet 3-4-1N.

C. Remove a minimum of two (2) specific integrated circuits (TO-5 IC's), from an instructor selected conformal coated micro-electronic printed circuit board, using the correct micro conformal coating removal method and micro electronic desoldering techniques as outlined in Volume 6 of the PACE Rework and Repair Technology Series and the information contained in Notetaking Sheet 3-4-1N.

NOTE: Micro-electronic circuit boards may be presented at any time for informal evaluation on work being performed prior to grading. Constructive comments by the instructor on micro coating removal and desoldering techniques will be offered as information.

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in the completed circuit boards with a minimum of two (2) specific components removed from each circuit board for grading by the thirteenth day of the course. Removal of the coated components must be performed with no damage or degradation to the components or circuit boards and meet the acceptable standards outlined in Volume 6 of the PACE Rework and Repair Series and Notetaking Sheet 3-4-1N to receive a satisfactory (SAT) completion grade. If any circuit board is determined to be unsatisfactory (UNSAT), the student will be permitted to rework and resubmit them for grading, by the fourteenth day. Two UNSAT's on the same task will be cause for convening an academic board and possible drop from the course.

IV. EQUIPMENT:

A. One 2M Kit

B. One conformal coated micro circuit board with dual-in-line components

C. One conformal coated micro circuit board with Flat pack components

D. One conformal coated micro circuit board with TO-5 IC components

E. Consumable supplies as necessary

PLEASE READ COMPLETE DIRECTIONS BEFORE PROCEEDING

Performance Test 4-4

MICRO-ELECTRONIC CIRCUIT SOLDERING TECHNIQUES

I. PURPOSE:

To determine the proficiency with which the student performs the following tasks:

A. Replace selected components parts on micro-electronic circuit boards using the correct tools and high reliability soldering techniques to the acceptable standards illustrated in MIL-S-45743E and described in Notetaking Sheet 4-4-1N.

II. PERFORMANCE:

A. Install a minimum of two (2) dual-in-line (DIP's) components on an instructor selected micro-electronic circuit board using preferred mounting and termination styles and high reliability soldering techniques to the acceptable standards outlined in MIL-STD-454D, MIL-S-45743E and Notetaking Sheet 4-4-1N.

B. Install a minimum of two (2) flat pack (FLAT PACK's) components on an instructor selected micro-electronic circuit board using preferred mounting and termination styles and high reliability soldering techniques to the acceptable standards outlined in MIL-STD-454D, MIL-S-45743E and Notetaking Sheet 4-4-1N.

C. Install a minimum of two (2) integrated circuit (TO-5-IC's) components on an instructor selected micro-electronic circuit board using preferred mounting and termination styles and high reliability soldering techniques to the acceptable standards outlined in MIL-STD-454D, MIL-S-45743E and Notetaking Sheet 4-4-1N.

NOTE: Micro-electronic circuit boards may be presented at any time for informal evaluation on work being performed prior to grading. Constructive comments by the instructor on installation of micro components and soldering techniques will be offered as information.

938

III. TIME REQUIRED PER STUDENT:

Each student will be required to turn in the completed microelectronic circuit boards with a minimum of two (2) specific components installed on each board for grading by the fourteenth day of the course. Installation of the components must meet the acceptable standards outlined in MIL-S-45743E and Notetaking Sheet 4-4-1N to receive a satisfactory (SAT) completion grade. If any circuit board is determined to be unsatisfactory (UNSAT), the student will be permitted to rework and resubmit them for grading by the fifteenth day. Two UNSAT's on the same task will be cause for convening an academic board and possible drop from the course.

IV. EQUIPMENT:

A. One 2M Kit
B. Two dual-in-line (DIP's) components
C. Two flat pack (FLAT PACK's) components
D. Two TO-5-IC's
E. Three micro-circuit boards
F. Consumable supplies as necessary

1624